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AND
MAGAZINE OF NATURAL HISTORY,
INCLUDING
ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND
CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY.')

CONDUCTED BY
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"Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex æconomiâ in conservatione, proportionè, renovatione, *potentia* majestatis elucet. Harum itaque indagatio ab hominibus sibi relictis semper æstinata; à verè eruditis et sapientibus semper exulta; malè doctis et barbaris semper inimica fuit."—LINNÆUS.

"Quel que soit le principe de la vie animale, il ne faut qu'ouvrir les yeux pour voir qu'elle est le chef-d'œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations."—BRUCKNER, *Théorie du Système Animal*, Leyden, 1767.

. The sylvan powers
 Obey our summons; from their deepest dells
 The Dryads come, and throw their garlands wild
 And odorous branches at our feet; the Nymphs
 That press with nimble step the mountain-thyme
 And purple heath-flower come not empty-handed,
 But scatter round ten thousand forms minute
 Of velvet moss or lichen, torn from rock
 Or rifted oak or cavern deep: the Naiads too
 Quit their loved native stream, from whose smooth face
 They crop the lily, and each sedge and rush
 That drinks the rippling tide: the frozen poles,
 Where peril waits the bold adventurer's tread,
 The burning sands of Borneo and Cayenna,
 All, all to us unlock their secret stores
 And pay their cheerful tribute.

J. TAYLOR, *Norwich*, 1818.



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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SIXTH SERIES.]

"..... per litora spargite muscum,
Naiades, et circum vitreos considite fontes:
Pollice virgineo teneros hic carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchyliis succo."
N. Partheni Giannettasti Eol. l.

No. 55. JULY 1892.

I.—*Natural History Notes from H.M. Indian Marine Survey Steamer 'Investigator,' Lieut. Gordon S. Gunn, R.N., commanding.*—Series II., No. 4. *Some Observations on the Embryonic History of Pteroplatæa micrura.* By A. ALCOCK, M.B., Surgeon-Naturalist to the Survey.

[Plate IV.]

1. Introduction.

PROFESSOR WOOD-MASON and I have shown that in *Pteroplatæa micrura* the ovum is retained within the uterus, and, further, that the uterine mucous membrane is furnished with nursing-filaments, or trophonemata, which secrete a "milk" that supplies the embryo with nutriment during the later stages of its development and up to the day of its birth.

Though we had examined a good many pregnant females, we had not up to the time that our researches were published met with any that exhibited the earlier stages of embryonic development. But in February last, while the 'Investigator' was surveying the Godávari Delta, I was fortunate enough to capture a female of *Pteroplatæa micrura* (Bl. Schn.) in an early stage of pregnancy—double in the right uterus and triple in the left; and in this paper I propose to give, first, a

short account of three matters of interest in connexion with this specimen, namely: (1) the form of the young embryo itself, (2) the structure and relations of the gill-filaments, which in this stage make up a large part of the bulk of the embryo, and (3) the structure of the maternal nursing-filaments, or trophonemata, which at this stage appear to be only preparing for their special secretory function—and, lastly, to offer some suggestions (1) as to the bearing of the facts of the individual history of these embryos upon the problem of the ancestral history of the genus, and (2) as to a possible interpretation through these embryos of the phenomenon of aplacental viviparity among the Elasmobranch fishes.

2. *The Early Embryo of Pteroplatea micrura.*

The embryo* now to be described is about 29 millim. long; it has a remarkable generalized shark-like form (fig. 1), its snout, its gill-openings, and its tail having a Selachoid and not at all a Batoid appearance.

The *snout* is produced far beyond the mouth and is bluntly conical.

The *gill-openings*, from whatever aspect seen, are remarkable. From the dorsal view the branchial region forms on each side an inflated chamber in which the broad branchial bars are plainly visible; anteriorly the first slit forms the wide-open spiracle, but the other slits, five in number, are closed, and are conspicuous only because of the large blood-vessels which run in them. From the side view six nearly equidistant clefts are seen, the first being the spiracle and the other five being still closed but very plainly visible on account of their vascularity. It is only ventrally that the gill-slits, here very short and comparatively inconspicuous, are open to give issue to a cloud of delicate filaments, many of which when straightened out are nearly twice the length of the embryo itself, and the sum of which forms at least one third of the whole volume of the embryo.

The *trunk* is cylindrical and Selachoid and ends in a thick cylindrical shark-like tail, which bears terminally a long ventral and a shorter but deeper dorsal tail-fold.

The *pectoral fins* are large, their base being coextensive with the length of the trunk; each is prolonged forward, parallel with but quite separate from the branchial region, and in the same plane with the head, into a tapering bar, which, however subsequently curled, starts with an inward

* One embryo, typical of all, has been selected for this description.

twist. If the head were more depressed, and if at the same time the prolongation of the pectoral fins were broader and more truncated, the result would be a by no means fanciful resemblance to *Rhina*.

The *ventral fins* are small and lie well free from the hinder limit of the pectorals.

The embryo is still attached by a broad cord, about 12 millim. long, springing from the belly between the front border of the pectoral fins, to a large yolk-sac, which appears to consist entirely of a diffuent yolk hardly more stable than oil, enclosed in a membrane of extreme tenuity. The gill-filaments are in intimate relation with this yolk, closely and completely enveloping it on all sides. The cord of attachment is so delicate, yet so broad withal, that I have not succeeded in cutting complete transverse sections; but this much is quite certain, both from examination of partial transverse sections and from examination of portions of a stained cord mounted flat as transparent objects in glycerine, that it consists of a solid mass of close-packed large-nucleated cells, and is longitudinally traversed by numerous lacuniform channels of very irregular outline and of unequal size, and that these channels contain NOT BLOOD-CELLS, BUT SMALL SPHERULES OF YOLK ONLY. In short, nothing of the nature of a distinctly defined artery or vein, or indeed of any vessel containing blood-cells, is to be made out; and this must be looked upon as a fact of the highest significance, not merely when we come to seek an explanation of the use of the gill-filaments in this species, but when we come to consider the much wider question of embryonic nutrition among the aplacentally viviparous Elasmobranchs in general.

3. *The Gill-filaments of the Early Embryo of Pteroplatæa micrura.*

These issue ventrally from all the gill-slits except the spiracle, and closely embrace the yolk-sac; if they have any additional attachment to the uterine wall it must be of the feeblest nature. Their total volume in the fresh state was not less than one third that of the entire embryo.

They vary in length, most of them being considerably longer than the embryo itself; their breadth is about 0.5 millim. and their thickness is quite inappreciable by the unaided eye.

A filament stained with carmine, mounted flat in glycerine, and examined as a transparent object under a low power (fig. 2) has a uniformly granular appearance—due to the

close crowding of the very large nuclei of epithelial cells that closely invest its surface—and shows a longitudinal light band occupying a little more than its median third, flanked by a dark band occupying on each side a little less than its marginal third; and when the end of the filament is brought into view the lateral dark bands are found to directly inosculate round its tip. The dark marginal band is in fact a broad capillary filled with blood-clot, disposed in a long narrow loop.

Under a higher power the surface of the filament is seen to be uninterruptedly covered with polygonal epithelial cells in the closest possible contact with one another. These cells are remarkable in consisting of little but a large vesicular nucleus lying within a thin and difficultly visible capsule of cell-protoplasm; the nuclei have a diameter varying from 7·5 to 10 micromillimetres, and are often polygonal by mutual compression.

A transverse section of a filament looks like a pair of *pince-nez* (fig. 3), each lens of the *pince-nez* being formed of a cross-section of a simple capillary tube, with a wall one cell thick, enclosed in a frame formed by a single row of large nucleated epithelial cells, and the bridge of the *pince-nez* being formed of two rows of these cells with a layer of flat nuclei, continued across from the capillary wall on each side, between them.

To recapitulate and restate: a gill-filament is nothing more than a long narrow loop of a capillary of wide bore with a wall one cell thick, enclosed in a folded sheet, also only one cell thick, of small epithelial cells which consist of little but a great nucleus.

As to the function of the gill-filaments: their vascularity and the nature of their epithelium clearly indicate great activity. They do not seem to have any attachment to the uterine wall, but, on the other hand, the manner in which they enfold the yolk-sac leads to the belief that they assist in absorbing the nutrient yolk. And the irregular indefinite nature of the channels of the stalk of the yolk-sac, which channels, moreover, seem to carry only yolk-particles and not blood, seems to give strong support to this view.

4. *The Uterine Trophonemata of Pteroplatæa micrura in the Earlier Stages of Pregnancy.*

The structure of the nursing-filaments when in active function for the benefit of the foetus has already been described and figured by Professor Wood-Mason and myself (*vide* 'Proceedings of the Royal Society,' vol. xlix. pp. 359-367),

and all that is now necessary is to draw attention to the slight but significant differences which are observed in this earlier stage while the embryo has still an ample fund of yolk to draw upon—differences which enable us to picture the mode of development of the milk-secreting elements.

In the specimen under notice the nursing-filaments mainly differ to the naked eye from those originally described in being altogether smaller and in being uniformly distributed like a coarse thick fur over the entire surface of the uterine mucous membrane, instead of being restricted to certain definite areas.

Their average length is 11 millim. and their average width about 1.25 millim. at the base and about 0.75 millim. near the tip, and they are flat with a tendency to curl.

When a trophonema is stained with carmine and examined in glycerine as a flat transparent object, under a low magnifying power, the blood-vessels first attract attention. Running in the margin, from base to apex on each side, is seen a small artery which at the tip of the filament flows each into its fellow, either in a single loop or, after a single acute-angled bifurcation, in a double loop, as shown in fig. 4. All along its course this marginal arterial loop sends off from its concavity numerous small branches, which form a dense superficial capillary plexus with its long narrow meshes transverse to the long axis of the trophonema; and deeply beneath this plexus, running up the middle of the trophonema in its basal half only, is a spiral vein of some size. Higher magnification shows that the surface of the trophonema is uniformly covered with pavement epithelium, which dips down, but does not become discontinuous, in the slightly excavated intercapillary meshes.

A transverse section of a trophonema (fig. 5) shows at either extreme the artery and near the middle the wider but not very much wider vein cut straight across, the superficial capillaries cut through in various planes, and at the circumference of the section an unbroken ring of pavement epithelium presenting slight depressions in many places between the cut capillaries. Beneath the epithelium, stretching from artery to artery but not round the arteries, on both faces of the narrow section, is a long close line of pocket- or bulb-shaped nests of cells, which in some cases are quite solid, in other cases are hollowed out in the centre, and in yet other cases form true acini "pointing," to use a surgical metaphor, towards the superficial intercapillary depressions of the surface epithelium above alluded to.

It is unnecessary to go further into histological detail, since

enough has been said to enable us to understand the meaning of these appearances.

In transverse sections of a trophonema taken from a long-gravid uterus in which the foetus, having used up all the yolk, is now demanding other nourishment, there is, as has been shown in the paper already quoted, little to be seen but two opposed rows of bulb-shaped milk-secreting glands with funnel-shaped mouths, separated by a vascular space. These glands take the place of the more or less solid nests of cells seen in the above-described sections of trophonemata from a gravescent uterus. And in comparing this less mature with that more mature stage we come to the conclusion that in *Pteroplatea micrura*, as Professor Wood-Mason and myself have already shown to be the case in *Trygon walga*, the secreting glands of the nursing-filaments, like the alveoli of the milk-glands in Mammals, begin as solid nests of epithelium, which, with the onset of active secretion, gradually become hollow chambers by the breaking down and exfoliation of their core.

5. Considerations as to the Descent of the *Pteroplatean Alliance.*

I hope before long to give a more complete account of the embryonic history of *Pteroplatea micrura*, from which perhaps it may be more permissible than it can be from the meagre facts just recorded to attempt to retrace the pedigree of the Trygons. But on account of the recent revival of interest in the phylogeny of the Batoidei it will, I trust, be considered pardonable to touch a few points, from all of which we can, without straining, bring these embryos into the field of vision.

It is impossible to see these little embryos without in the first place being struck by their shark-like form; and when next attention is fixed upon the gill-openings—their conspicuous dorsad extension and their relation to the prolonged pectoral fins—one is immediately reminded of *Rhina*. Indeed all that is needed is to straighten out and flatten the pectoral fins and to depress the head in order to get a strong resemblance to that interesting intermediate form. Or, if we leave the pectoral prolongations untwisted and imagine them in this condition fused with the head, we get a remarkable likeness to *Ceratoptera* and *Dicerobatis*.

The descent of the Trygonidæ from a shark-like ancestor is of course, from what is well known of *Raja* and *Torpedo*, only what would be expected; but I do not know whether or not the suggestion that the line of descent passes (1) through

a *Rhina*-like form, and (2) through a Myliobatoid form, is equally familiar. At any rate it is a suggestion that arises quite naturally from an external view of the pectoral fins and gill-slits of these embryos of *Pteroplatæa micrura*.

Professor G. B. Howes, in his most interesting paper "On the Pectoral Fin-Skeleton of the Living Batoid Fishes" &c. (P. Z. S. 1890, pp. 675-688), incidentally suggests an alliance between *Rhina* and the Ceratopteryine Myliobatoids; and Herr Otto Jaekel (SB. Ges. nat. Fr. Berlin, March 1890), in a paper of great interest, for the knowledge of which I am indebted to Professor Howes, has drawn attention to the importance of the disposition of the gill-slits in relation to the pectoral fins for the purposes of a natural (phylogenetic) classification of the entire order, and has laid stress upon the Batoid affinities of *Rhina*.

6. Considerations as to the Origin of Aplacental Viviparity among the Elasmobranchs.

If it is premature to jump from these embryos back to their supposed ancestral relatives, it is equally premature to attempt from them alone to interpret the meaning of the aplacental viviparity of the Batoid fishes as a whole. The subject, however, is so very tempting that one cannot refrain from recording certain suggestions that naturally arise out of an examination of the yolk-sacs and umbilical cords of these embryos of *Pteroplatæa*.

The methods of reproduction among Elasmobranchs are three, namely (1) oviparity, (2) viviparity with the formation of a placenta, and (3) viviparity without the formation of a placenta.

We know how the second naturally arises directly out of the first; the large egg is retained in the terminal portion of the oviduct, and in the process of development, from early common arrangements by which "nutriment from the yolk-sac is brought to the embryo partly through the umbilical canal and so into the intestine, and partly by means of blood-vessels in the mesoblast of the yolk-sac" * and so into the general circulation, we come at last in these viviparous forms to later special arrangements by which, when the yolk is finished, nutriment from the maternal blood-vessels in the uterine mucous membrane is brought to the embryo by means of the greatly developed foetal blood-vessels of a yolk-sac which has now, after the disappearance of the yolk and the

* Balfour, 'Comparative Embryology,' 2nd edition, vol. ii. p. 64.

obliteration of the communication between the umbilical canal and the intestine, become a placenta.

Now from the non-vascular condition of the yolk-sac and umbilical canal in the embryos under consideration we may venture to surmise the possibly equally direct origin of aplacental viviparity from simple oviparity.

Here again the large egg remains in the terminal portion of the oviduct, and in the process of development external gills which had originally "very possibly become specially developed to facilitate respiration within the egg" * become otherwise specialized to absorb nutriment from a yolk-sac which has only the single communication with the embryo through the umbilical canal and intestine. When the yolk is all finished the nutriment which is secreted from the maternal glands naturally follows, in the absence of any absorptive blood-vessels in the empty yolk-sac, the already established route through the branchial clefts, one of which (the spiracle), being unobstructed by gill-filaments, becomes at last the exclusive channel of supply.

I should like, in concluding this paper, to express my obligations to Professor Howes for his extreme kindness in sending out to me on loan, at great risk owing to distance, his own copies of Herr Jaekel's and others' papers on the subject of the affinities of the Batoids—an act of kindness and consideration which a ship's naturalist, cut off for months from all but a few standard classics, can hardly over-appreciate.

EXPLANATION OF PLATE IV.

- Fig. 1.* Embryo of *Pteroplatæa micrura*, from dorso-lateral aspect; nat. size, but with only a few of the gill-filaments represented, for the sake of clearness. *s*, spiracle.
- Fig. 2.* End of a gill-filament, showing the marginal capillary filled in places with blood-clot. $\times 42$.
- Fig. 3.* Transverse section of a gill-filament, showing the marginal capillary in section and the single fold of epithelium. $\times 188$. For the sake of clearness the blood-clot is represented in one limb of the capillary only, and the spaces between the nuclei of the surface epithelium are a little exaggerated.
- Fig. 4.* End of a trophonema, or nursing-filament, seen as a transparent object in glycerine, showing the marginal artery and the superficial capillary plexus. $\times 42$. The median vein is not seen so near the end.
- Fig. 5.* Obliquely transverse section through a nursing-filament, showing the glands still in the form of solid bulbs lying beneath a still unbroken surface of epithelium. $\times 110$. *a*, *a*, arteries; *v*, vein; *c*, *c*, superficial capillaries.

* Balfour, *op. et tom. cit.* p. 62.

II.—On some new or little-known Fishes obtained by Dr. J. W. Evans and Mr. Spencer Moore during their recent Expedition to the Province of Matto Grosso, Brazil. By G. A. BOULENGER.

[Plates I. & II.]

Plecostomus pantherinus, Kner.

Nothing could be more misleading than a division of the fishes of the genus *Plecostomus* according to the presence or absence of granular plates on the belly. Among the numerous specimens of *P. bicirrhosus* in the British Museum there are some with the belly partly or entirely naked (the latter being young) which are not to be otherwise distinguished from the typical form. Thus, in three specimens (one half-grown and two young) from British Guiana the belly is naked in one young, partly naked in the other, entirely granulate in the larger specimen. It is therefore very probable that *P. seminudus*, Eigenmann, will turn out to be merely an individual variation of *P. bicirrhosus*. With regard to the specimens which I refer to Kner's *P. pantherinus*, described from a single young specimen from the Rio Guaporé, the much larger eye distinguishes them at once from *P. bicirrhosus*, their nearest ally; in Kner's specimen, 3 inches long, the eye measures one fourth the length of the head, whereas it measures only one fifth or one sixth in *P. bicirrhosus* of similar size. In the adult *P. pantherinus* the diameter of the eye is one fifth the length of the head, against one seventh or one eighth in *P. bicirrhosus*. The head is besides larger in proportion to the body in the former than in the latter.

Two specimens were obtained by Dr. Evans in the River Jangada, close to Jangada village; the larger measures 200 millim. (to the end of the middle caudal rays), the smaller 170.

Form stout. Head as long as broad, one third total length (without caudal); snout rounded, with a small naked space at its extremity; an obtuse ridge from the upper angle of the orbit to below the nostril, the sides of the head below it being slightly concave; an obtuse ridge on the occiput and another on each side behind the eye; interoperculum with small spines. Diameter of orbit one fifth length of head, one third length of snout, three fifths to one half interorbital width, and equal to its distance from the posterior border of the head. Labial fold moderate, papillose, not or but slightly notched; barbel short. Dorsal 17, the first ray as long as or

a little longer than the head. Anal 5. Pectoral I 5, nearly as long as the head, and extending beyond the base of the ventral. Ventral I 5. Lower caudal lobe longer than upper. Scales $25\frac{2}{3}$; lateral line 25. Breast and belly partly naked; in the smaller specimen the anterior portion of the belly is covered with granular plates extending right across, in the larger specimen these granulations are confined to the sides and a median strip; 12 scales between the anal and caudal fins. Dark olive-brown, with rather indistinct round black spots, which are smaller and closer together on the head.

Plecostomus cochliodon, Kner.

Of this remarkable fish, of which, like the preceding, no other but the type, preserved in the Vienna Museum, was hitherto known, a single specimen was obtained by Dr. Evans at Jangada. It measures 180 millim. Its fins are unfortunately much damaged. In every respect it agrees with Kner's description. Lateral line 28.

The difference in the dentition being merely one of degree, and the fish agreeing in other respects so closely with the other species of *Plecostomus*, I doubt whether it is advisable to separate it as a distinct genus (*Cochliodon*).

Loricaria Evansii, sp. n. (Plate I.)

Teeth well developed in both jaws. Head a little longer than broad, one fourth total length (without caudal); snout obtusely pointed, with long bristles on the sides; three short keels on the back of the head; postorbital notch scarcely distinct; diameter of orbit one sixth length of head, two sevenths length of snout, and two thirds interorbital space, which is concave. Labial fold much developed, notched, papillose, and with long cirrhi. Dorsal I 7, the first ray two sevenths length of head, and just above the base of ventrals. Anal I 5. Pectoral I 6, a little shorter than head, extending to base of ventrals. Ventral I 5, as long as pectoral, reaching anal. Upper caudal ray produced in a long filament, half as long as head and body. Lateral scutes 29, with two spinose ridges meeting on the 19th; nuchal scutes with spinose keels; 20 scutes between dorsal and caudal, 17 between anal and caudal; breast and belly naked, but rough with minute spines; a series of seven or eight shields between pectoral and ventral on each side of the thorax. Olive-brown above; a dark band across the nape, and four others between the dorsal and caudal fins; fins with black spots.

Total length 205 millim.

A single specimen from Jangada.

This fish is evidently very closely allied to *L. nudiventris*, known from a single specimen from the Rio San Francisco, described by Cuvier and Valenciennes. It differs, however, in having seven or eight shields on each side of the lower surface, between the pectoral and ventral fins, instead of four.

Tetragonopterus Moorii, sp. n. (Pl. II. fig. 1.)

Length of head $3\frac{3}{4}$ times in total length (without caudal), depth of body $2\frac{3}{4}$. Maxillary toothless, extending to below the centre of the eye; diameter of eye $\frac{1}{2}$ length of head, $1\frac{1}{2}$ length of snout, equal to interorbital width; adipose eyelid short. Dorsal I 10, originating above base of ventrals. Anal II 28, originating a little behind the vertical of the base of the dorsal. Pectorals reaching base of ventrals, ventrals reaching origin of anal. Scales 37-38 $\frac{8}{7}$; lateral line complete. A black spot behind the shoulder; a silvery lateral stripe, turning to black on the tail and extending on the caudal.

Total length 75 millim.

Two specimens were collected by Mr. Moore on the Chapala plateau.

The nearest ally of this new species appears to be *T. maximus*, Sldr. (*alosa*, Gthr.), from the Peruvian Andes, which differs in having the interorbital region wider.

BRACHYCHALCINUS, gen. nov.

Intermediate between *Tetragonopterus*, Cuv., and *Luetkenia*, Sldr. Dentition as in the former, viz. two præmaxillary and one mandibular row of tri- or quinquecuspid teeth; body elevated, with sharp ventral edge. Differing from both in having a movable spine, directed forwards, in front of the dorsal fin.

In one of the three specimens (probably a male) this spine is hammer-shaped, its free portion forming a longer anterior and a shorter posterior branch, both of which are sharply pointed; in the two others (one of which I have ascertained to be a female) the posterior process is wanting and the anterior is more developed but not spinose, spoon- or saddle-shaped, rounded at the end, concave below, and fitting into a notch in the back in front of the dorsal fin. The differences in this curious arrangement will probably prove to be correlative of the sexes. In *Serrasalmo* the first interneural bears likewise a spine directed forwards, which is bicuspid behind and scarcely movable.

Brachychalcinus retrospina, sp. n. (Pl. II. fig. 2.)

Length of head 4 to $4\frac{1}{2}$ times in total length (without caudal), depth of body $1\frac{1}{2}$ to $1\frac{1}{3}$. Maxillary toothless, nearly vertical, not extending beyond the anterior border of the eye; diameter of eye half length of head, once and two thirds length of snout, equal to interorbital space; dorsal profile ascending abruptly from above centre of eye; a very short adipose eyelid in front. Dorsal I 11, just behind vertical of base of ventrals. Adipose fin well developed. Anal II 31-34. Pectorals slightly shorter than head, not quite reaching ventrals. Latter small, I 6. Scales 33-35 $\frac{9-10}{10-11}$; lateral line complete. A silvery lateral stripe; fins speckled with black, adipose black-edged.

Total length 80 millim.

Three specimens, from Santa Cruz.

I seize this opportunity to point out that *Pseudocorynopoma Doriae*, Perugia, Ann. Mus. Genova, (2) x. 1891, p. 646, fig., and *Bergia altipinnis*, Steindachner, Anz. Ak. Wien, 1891, p. 173, and SB. Ak. Wien, C. i. 1891, p. 366, pl. ii. fig. 2, are identical. Perugia's description (April) has priority over Steindachner's (July).

The other species represented in Messrs. Moore and Evans's collection are the following:—

- Acara viridis*, Heck. Corumba.
- Pimelodus*, sp. (young). Chapala Plateau.
- Macrodon trahira*, Bl. Schn. Corumba.
- Erythrinus unitæniatus*, Spix. Corumba.
- Pyrrhulina semifasciata*, Stdr. Corumba.
- Leporinus megalepis*, Gthr. Santa Cruz.
- Tetragonopterus orbicularis*, C. & V. Santa Cruz.
- *lacustris*, Rhdt. Corumba.
- *rivularis*, Ltk. Chapala Plateau.
- Chalcinus paranensis*, Gthr. Corumba.
- Xiphorhamphus ferox*, Gthr. Santa Cruz.

EXPLANATION OF THE PLATES.

PLATE I.

Loricaria Evansii, $\frac{1}{4}$ nat. size.

PLATE II.

Fig. 1. *Tetragonopterus Moorii*.

Fig. 2. *Brachychalcinus retrospina*.

III.—*On some Teeth of new Chimæroid Fishes from the Oxford and Kimmeridge Clays of England.* By A. SMITH WOODWARD, F.L.S., F.Z.S., of the British Museum (Natural History).

[Plate III.]

NOTWITHSTANDING the fact that the number of forms of Chimæroid teeth known from Mesozoic formations is already large, there are still several specimens in the British Museum that cannot be assigned to the genera and species as yet described. More especially does this remark apply to the collection of Alfred N. Leeds, Esq., of Eyebury, lately received; for if the characters of the teeth can be relied upon in generic diagnoses (as seems probable), the small series of specimens from the Oxford Clay of Peterborough, collected by Mr. Leeds, makes known the occurrence of two distinct genera hitherto unrecognized. There are also some small teeth from the Kimmeridge Clay of Weymouth, which are partly identical with one of Mr. Leeds's fossils, and partly seem to indicate even a third genus as yet unknown in the Jurassic. It is with the systematic arrangement of these specimens that the present communication deals.

A general summary of existing knowledge on the subject of the Mesozoic Chimæroid fishes will be found in the second part of the British Museum 'Catalogue of Fossil Fishes,' and the following descriptions are arranged to be uniform in style with that work.

Genus PACHYMYLUS, nov.

Diagnosis.—Mandibular tooth massive, with a well-defined hard layer upon the outer aspect immediately below the oral margin, and a very broad symphysial facette; one median tritor forming a prominent boss; anterior and anterior-outer tritor absent; posterior outer tritor represented by few small patches. Palatine tooth robust, with a single, large, prominent tritor.

Remarks.—The upper and lower teeth, here placed together, have not yet been found in natural association; but they agree so closely in character that there can be no doubt as to their pertaining to one and the same fish. Regarded as Jurassic fossils they are of much interest, from the great

width of the mandibular symphysis, the remarkable reduction of the tritoral areas, and the prominence of the median tritor that remains.

Pachymylus Leedsi, sp. n. (Pl. III. figs. 1, 2.)

Diagnosis.—A species attaining to a large size, the measurement from the middle of the symphysial border to the extremity of the post-oral margin of the type mandibular tooth being 0.14 m. *Mandibular tooth* with a prominent beak, and the symphysial facette occupying about one third of the inner aspect; median tritor narrow, occupying only one sixth of the length of the oral face; posterior outer tritor reduced to three small, round, punctated areas. *Palatine tooth* diverging from its fellow of the opposite side in front, and terminating anteriorly in a sharp, chisel-like edge; median tritor occupying much less than half the width of the tooth and separated by a space equal to its own length from the anterior border. [*Vomerine tooth* unknown.]

Remarks.—This, the type species of the genus, is based upon the mandibular tooth and the pair of palatine teeth shown of two thirds the natural size in Pl. III. figs. 1, 2. The state of preservation of all the specimens is good, the hinder border only of the palatine teeth being partly destroyed. Viewed from the oral aspect (fig. 1) the palatine teeth exhibit a slight want of symmetry; and there is a marked line of weakness round the elevation on which the tritor is placed, this line being indicated by the fracture in the tooth of the left side. The inner face of each palatine tooth (fig. 1 *b*) exhibits the fibrous texture of the cement and exposes the base of the tritor in irregular, narrow, oblique stripes; the outer face (fig. 1 *a*) shows the strengthened external border, while the tritoral prominence is also conspicuous from this aspect. Seen from the inner face (fig. 2) the mandibular tooth exhibits its robust character; and a direct view of the symphysial facette (fig. 2 *a*) shows its very broad rhomboidal form. The external oral border of the mandibular tooth is strengthened, but not far beneath this border the outer face in the fossil is crushed and destroyed.

Formation and Locality.—Oxford Clay, Peterborough.

Genus BRACHYMYLUS, nov.

Diagnosis.—Mandibular tooth short and deep, much laterally compressed, the symphysial facette narrow, and the

oral border scarcely sinuous; the symphysial, median, and posterior outer tritons deep and narrow; anterior outer tritor absent. [Palatine and vomerine teeth unknown.]

Remarks.—This genus is founded on the form of mandibular tooth recorded in the British Museum Catalogue (pt. ii. pp. 551, 552) as possibly referable to very young individuals of *Ischyodus Beaumonti*. The diminutive specimens from the Kimmeridge Clay of Weymouth noticed in that work did not seem to justify the foundation of a distinct genus and species; but a nearly similar mandibular tooth measuring 0·033 m. in length, now available in the Leeds Collection, shows that the fossils in question truly pertain to a hitherto unknown fish. In general outline they are most closely similar to the mandibular teeth of *Ischyodus Dufrenoyi*.

Brachymylus altidens, sp. n.

Diagnosis.—*Mandibular tooth* about as deep as long, with a regularly excavated sharp oral border and short beak; post-oral margin parallel with the symphysial; beak-tritor and posterior outer tritor very small; median tritor occupying less than one third of the length of the oral face and situated in its hinder half.

Remarks.—This species is known only by the left mandibular tooth, which measures 0·033 m. in length and is complete with the exception of the tip of the beak. The oral border of the tooth is very sharp and dense, but there is no conspicuous strengthening layer on the outer face.

Formation and Locality.—Oxford Clay, Peterborough.

Brachymylus minor, sp. n.

Diagnosis.—*Mandibular tooth* with a very slightly excavated, somewhat wavy, sharp oral border and insignificant beak; post-oral margin parallel with the symphysial, and its length much exceeding the antero-posterior measurement of the tooth; all the tritons small, the median tritor occupying less than one third of the oral face and situated in its hinder half.

Remarks.—The three teeth thus described (Brit. Mus. nos. 41866–67) differ from the corresponding tooth of the type species in the comparative straightness of the oral border and the relatively great length of the post-oral border. They are also distinguished by their very small size, the antero-

posterior measurement of the largest specimen (41866) being only 0·015 m.

Formation and Locality.—Kimmeridge Clay, Weymouth.

Genus ELASMODECTES, Newton.

[Mem. Geol. Survey, iv. 1878, p. 43 (*Elasmognathus*).]

Elasmodectes secans, sp. n. (Pl. III. fig. 3.)

Diagnosis.—*Mandibular tooth* with a moderately sinuous oral margin, and the post-oral border inclining backwards more than the symphyseal border; outer tritons very small and undivided, coarsely laminated.

Remarks.—The type specimen is the small left mandibular tooth shown of the natural size in Pl. III. fig. 3, from the inner (a) and outer aspect (b). The beak is unfortunately broken away, revealing the small beak-tritor in section; but the tooth is in other respects complete. It is remarkable as being the most sectorial form of mandibular dentition hitherto discovered in Jurassic rocks. Though differing from the typical Cretaceous *Elasmodectes* in the simple character of the outer tritons, it does not appear advisable on present evidence to refer the tooth to a distinct genus; for the normally simple outer mandibular tritons of *Ischyodus* are partially subdivided in some species, and such subdivision ought not thus to be always noted in generic diagnoses. When the palatine teeth of *E. Willetti* and of the form now described are discovered, it may be possible to determine definitely whether the two fishes in question are generically identical.

Formation and Locality.—Kimmeridge Clay, Weymouth.

EXPLANATION OF PLATE III.

- Fig. 1.* *Pachymylus Leedsi*, gen. et sp. nov.; pair of palatine teeth, oral aspect, two thirds nat. size. 1 a. Right palatine tooth, outer aspect, two thirds nat. size. 1 b. Left palatine tooth, inner aspect, two thirds nat. size.—Oxford Clay, Peterborough. [Leeds Collection.]
- Fig. 2.* Ditto; right mandibular tooth, inner aspect, two thirds nat. size. 2 a. View of symphysis of same specimen, two thirds nat. size.—*Ibid.*
- Fig. 3.* *Elasmodectes secans*, sp. n.; left mandibular tooth, inner (a) and outer (b) aspects, nat. size.—Kimmeridge Clay, Weymouth. [Brit. Mus. no. 43284.]

IV.—On the Genus *Hypocala*, a Group of Noctuid Moths.

By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

IN the seventh volume of the 'Illustrations of Typical Lepidoptera Heterocera,' p. 76, I pointed out that the species of *Hypocala* were trimorphic: this fact has led to so much confusion that a revision of the species has become a necessity. When once understood the forms of this genus are easily recognizable; the primaries on the upper surface vary considerably, but always in the same way; the secondaries and the under surface are constant in pattern in all the modifications of each species.

M. Guenée, who would never identify an insect from a rough figure, and yet rarely failed to describe every differing form in his possession, however bad the specimen might be, multiplied species unnecessarily.

Whether from their rarity or the difficulty of capturing these moths, I do not know, but they seem to come to hand chiefly as individual specimens and at long intervals, so that of several of the species only one, or at most two, of the forms which represent the variations of each type have hitherto found their way to us. Mr. Hocking seems to have been more successful in collecting *Hypocala* than most men. In his Dharmasala series we obtained all three forms of *H. subsatura* in the following proportions:—five of the typical form, four of the variety *H. aspersa*, and four of the variety *H. limbata* (the last-mentioned having, up to that time, been unrecorded).

In the following synopsis I propose to define the species hitherto described with their varieties. In order to avoid repetition in diagnosing the forms it may be premised that any good figure (such, for instance, as that given by M. Guenée, 'Noctuélites,' iii. pl. xiii. fig. 7) will represent the general characteristics in the pattern of the genus, if one allows for the more blurred uniform character of the primaries in the variety which I regard as typical, and the sharply defined but melanic character of the form which I have characterized as var. *b*. The secondaries are always ochreous and black above, and the under surface is usually pale ochreous, more or less marked with blackish and greyish.

The under surface gives the best characters for the differentiation of the species, and therefore I shall make my primary divisions on points of difference to be seen on that surface of the wings.

- A. Wings below pale ochreous; primaries with black discal patch divided by a band of the ground-colour; secondaries with a black spot at end of cell and an oblique bar from anal angle to second median branch.
- a. Black patch on primaries broadly divided, leaving only a narrow bar of black on its inner edge; spot of secondaries small and anal bar very narrow *H. clarissima*.
- b. Black patch barely divided by a narrow central bar; spot of secondaries elongated, anal bar broad *H. violacea*.
- B. Wings below ochreous, greyish on costal and apical areas; primaries with a black discal patch enclosing an ovate transverse ochreous spot; secondaries with a black spot at end of cell; an irregular, partly marginal, black band from anal angle to just above lower radial vein, its outer edge interrupted by two spots, that nearest anal angle small and angular *H. florens*.
- C. Wings below ochreous, irrorated with purplish grey on costal and apical areas; primaries with the usual black discal patch represented by two rather broad, abbreviated, parallel, oblique bars; secondaries with a conspicuous spot at end of cell; the usual blackish band narrow, irregularly zigzag, broadly expanded at its upper extremity and extending from close to anal angle to second subcostal branch *H. deflorata*.
- D. Primaries below almost as in B, but the black patch bounded below by the first median branch; discocellular spot quadrate; the blackish band zigzag, alternately narrow and broad, extending from near anal angle almost to the first subcostal branch.
- a. Secondaries above chiefly ochreous, much more so than in any other described species *H. guttiventris*.
- E. Wings below with cell of primaries and inner two thirds of secondaries bright ochreous, remainder of ground-colour paler; apical area greyish, the latter and costal border striated with brown atoms; primaries with two broad black bars, converging at their lower extremities.
- a. Secondaries with a short, oblique, narrow, irregular black bar on the discocellulars; outer border blackish, shading into brown towards costa, becoming paler on margin towards apex and interrupted towards anal angle by an unequal, angular, ochreous, marginal patch towards anal angle..... *H. andremona*.
- b. Primaries with the black bars broader, almost touching at lower extremities; the inner bar emitting a broad grey streak below the cell almost to the base; secondaries with the blackish portion of the outer border broader, emitting a black denticle towards the lower extremity of the discocellular bar, interrupted towards the anal angle by two separate marginal ochreous spots. *H. subsatura*.

F. Wings below with costal and apical areas smoky grey, the black or blackish bars on the primaries almost united at lower extremity, the outer one diffused; the black or blackish external belt of secondaries broad, externally and apically diffused, excepting towards anal angle, where it is interrupted by a marginal clavate streak or spot.

a. Size of *H. andremona*, secondaries above with pale ochreous markings; external black border decreasing towards anal angle, deeply excavated just above the angle *H. Moorei*.

b. The largest known species; below deep ochreous, the inner black bar of primaries with an external denticle; discocellular bar of secondaries broad and externally angular; hind wings above with deep ochreous markings; external black border very broad before anal angle, moderately excavated just above the angle *H. australiæ*.

c. Similar to b, but with the whole under surface and the upper surface of the secondaries smoky, obscuring the markings, which are also paler and less defined in themselves *H. velans*.

Of the above species, all of which are represented in the Museum collection, we possess all three varieties of two species only. For the convenience of students of the group I give the following arrangement of the varieties, classified according to the colouring of the primaries, whether uniform, variegated, or bicoloured:—

| Uniform. | Variegated. | Bicoloured. |
|---------------------------|---------------------------|-------------------------------|
| <i>H. subsatura.</i> | <i>H. aspersa.</i> | <i>H. limbata.</i> |
| <i>H. deflorata.</i> | <i>H. plumicornis.</i> | <i>H. rostrata.</i> |
| <i>H. guttiventris.</i> | <i>H. lativitta.</i> | |
| <i>H. andremona.</i> | <i>H. Pierreti.</i> | |
| | <i>H. Moorei.</i> | |
| <i>H. australiæ.</i> | | |
| <i>H. velans.</i> | <i>H. velans.</i> | |
| <i>H. florens</i> (Mab.). | <i>H. florens</i> (Mab.). | <i>H. florens</i> (in B. M.). |
| <i>H. clarissima.</i> | | |
| <i>H. violacea.</i> | | |

It seems probable that the first and second forms (which appear to be inconstant and merge into each other) are one brood, and the very distinct-looking third form another; that they represent in fact either spring and autumn or dry- and wet-season forms of the species. Whether this is so or not can only be proved by breeding, and it is worth the consideration of those who have the opportunity of obtaining the eggs or larvæ.

*List of Species.**Hypocala subsatura.*

♂. *Hypocala subsatura*, Guenée, Noct. iii. p. 75. n. 1419 (1852).

Var. a. *Hypocala aspersa*, Butler, P. Z. S. 1883, p. 164.

Var. b. *Hypocala limbata*, Butler, Ill. Typ. Lep. Het. vii. p. 76, pl. cxxxi. fig. 13 (1889).

Dharmasala, Solun, and Canara. B. M.

Hypocala deflorata.

Noctua deflorata, Fabricius, Naturf. p. 190, pl. ii. figs. 6, 7.

Var. a. *Hypocala plumicornis*, Guenée, Noct. iii. p. 75. n. 1420 (1852).

Hypocala efflorescens, Guenée, l. c. p. 77. n. 1423 (1852).

Hypocala angulipalpis, Guenée, l. c. n. 1424 (1852).

Var. b. *Noctua rostrata*, Fabricius, Naturf. p. 197, pl. iv. fig. 4.

Madras, N. India, Dharmasala, Nilgiris, Kilima-njaro, Natal. B. M.

It is a common form of superstition amongst naturalists to assume that examples of the same species cannot occur both in India and Africa; M. Guenée was evidently strongly imbued with this opinion. The difference represented by the following words alone serves to separate *H. plumicornis* and *efflorescens*: of the first it is said, "Un seul ♂, qui m'a été envoyé comme venant de la Cafrerie: mais cette provenance me laisse quelques doutes." Why? Because in other respects it closely resembled *H. efflorescens*, of which we read, "Silhet. Coll. Gn. Un ♂." As for *H. angulipalpis*, it was based upon a single dwarfed and much rubbed example.

Hypocala guttiventris.

Hypocala guttiventris, Walker, Lep. Het. xiii. p. 1176. n. 10 (1857).

Hypocala tryphanina, Felder, Reise der Nov., Lep. iv. pl. cxii. fig. 20.

Var. a. *Hypocala lativitta*, Walker, Lep. Het. Suppl. iii. p. 929 (1865).

Moreton Bay and S.E. Australia. Type B. M.

Hypocala andremona.

Phalæna-Noctua andremona, Cramer, Pap. Exot. iv. p. 132, pl. cccviii. figs. C, D (1782).

Hypocala filicornis, Guenée, Noct. iii. p. 76. n. 1421, pl. xiii. fig. 7 (1852).

Var. a. *Hypocala Pierreti*, Guenée, l. c. p. 77. n. 1425 (1852).

Honduras, Amazons, São Paulo. B. M.

Hypocala Moorei, sp. n.

Var. *a. Hypocala efflorescens*, var., Walker, Lep. Het. xiii. p. 1175. n. 8 (1852); Moore, Lep. Ceylon, iii. p. 126, pl. clx. figs. 5, 5 a.

Ceylon, Canara, Old Calabar. B. M.

This is quite distinct from *H. efflorescens* of Guenée.

Hypocala australis, sp. n.

Secondaries above most like those of *H. subsatura*, but deeper and brighter in colour, with marginal ochreous spot.

Australia. B. M.

Represents *H. velans* in Australia.

Hypocala velans.

Var. *a. Hypocala velans*, Walker, Lep. Het. xiii. p. 1177. n. 11 (1852).

Hawaiian Islands. Type B. M.

Hypocala florens.

Hypocala florens, Mabilie, Trans. Soc. Ent. Fr. 1879, p. 324.

Madagascar. B. M.

M. Mabilie describes several forms of this species; our specimen belongs to the variety with pale inner border to the primaries (var. *b* of this monograph).

Hypocala clarissima, sp. n.

Differs from *H. violacea* above in the greater width of its ochreous markings.

Ceylon. B. M.

This and *H. violacea* both belong to the typical form of the genus in which the primaries are of a uniform character; both agree in having these wings of a lilacine rufous-brown colour.

Hypocala violacea.

Hypocala violacea, Butler, Trans. Ent. Soc. 1879, p. 6.

Cachar and Burmah. Type B. M.

Hypocala tenuis, Walk., from Sierra Leone, does not appear to me to belong to the genus; but the description is too poor to enable me to decide the point.

Hypocala biarcuata, Walk., from Canara, is either a species

of *Audea* (Catocalidæ) or belongs to a genus allied to *Audea*; it has nothing to do with *Hypocala*.

Hypocala lativitta, Moore (said to be nearest to *H. biarcuata*), is almost certainly a species of *Audea*; the porrect beak-like palpi of *Hypocala* are not shown in the figure, which, on the other hand, gives the impression of their being formed as in *Audea*.

V.—Description of a new Species of *Acomys*.

By OLDFIELD THOMAS.

AMONG a small collection of zoological specimens from Mombasa recently presented to the National Collection by Mr. D. J. Wilson, of the British East Africa Company's service, there occurs a specimen of a small spiny mouse clearly representing a new species. A second specimen of the same form has also been received direct from the Company, but the exact locality of this individual is unknown.

I propose to call the species

Acomys Wilsoni, sp. n.

Most nearly allied to *A. russatus*, Wagn., but distinguished from that, as from every other member of the genus, by its very much smaller size, and especially by its much shorter feet. General colour orange-rufous, grizzled with black, the black predominating on the head and nape. Under surface white. Ears small, rounded, laid forward they just reach to the posterior canthus of the eye. Feet short and broad; palms and soles naked, the pads well defined. Tail short, slender, very finely haired, almost naked; darker above, whiter below; rings of scales about seventeen to the centimetre.

Measurements of the type (an adult female in alcohol):—

Head and body 80 millim.; tail 48 (extreme tip wanting, 55 in the other specimen); hind foot 12·2; heel to front of last foot-pad 5·8; ear, above crown, 8·4.

Hab. Mombasa. Coll. D. J. Wilson.

The other species of the genus are all much larger than *D. Wilsoni*, with hind feet measuring from 16 to 19 millim., a difference in size so great as to preclude all necessity for a detailed comparison of the new form with them.

It is with much pleasure that I have named this little species in honour of its discoverer, to whose enthusiasm the British Museum is indebted for many rare and interesting specimens.

VI.—*General Observations on Fission and Gemmation in the Animal Kingdom.* By Dr. FRANZ VON WAGNER, Assistant in the Zoological Institute of the University of Strassburg*.

I.

THE asexual reproduction of the Microstomids, as described in the foregoing pages, has been hitherto theoretically claimed by the different investigators sometimes as gemmation, sometimes as fission.

If we disregard CErstedt †, who probably merely observed the folding of the intestine which is connected with the formation of septa, Oscar Schmidt was the earliest investigator of the multiplication of the Microstomids.

His diagnosis of the family "Microstomeæ" states ‡: "Reproduction by transverse fission." Moreover, in his description of the reproduction Schmidt characterizes it exclusively as fission. But even in the same year (1848) this investigator writes as follows §:—"I have designated the well-known multiplication of the Naids and Microstomids simply as transverse fission, although a glance at my figures will show that with this transverse fission is combined longitudinal growth of the portions which are to be constricted off. That, however, a part of the parent of those Turbellarians really passes into the new animal appears to me to be indisputable." But immediately afterwards (*loc. cit.* p. 37), when discussing the reproduction of *Filograna*, the same author states:—"If anywhere at all, it is here, at least in the case of the *Filograna* examined by me, that we see with especial clearness that the actual transverse fission is the least important stage in the development of the new animal, and that, on the contrary, the latter grows as a true bud or sprout upon

* Translated from the 'Zoologische Jahrbücher—Abtheilung für Anatomie und Ontogenie der Thiere,' 4 Bd. Heft iii. Dec. 1890, pp. 388–417: being the latter portion of a paper by Dr. Wagner, entitled "Zur Kenntnis der ungeschlechtlichen Fortpflanzung von *Microstoma*, nebst allgemeinen Bemerkungen über Theilung und Knospung im Thierreich," *ibid.* pp. 349–423 (with four plates).

† A. S. CErstedt, 'Entwurf einer systematischen Eintheilung und speciellen Beschreibung der Plattwürmer,' Copenhagen, 1844, p. 73.

‡ O. Schmidt, 'Die rhabdocelen Strudelwürmer des süßsen Wassers,' Jena, 1848, p. 22.

§ O. Schmidt, 'Neue Beiträge zur Naturgeschichte der Würmer,' Jena, 1848, p. 36.

the parent, and has its alimentary canal in common with it, as in the case of the old and young *Hydra* before separation has taken place.

In the last (1882) edition of his 'Vergleichende Anatomie' * Schmidt again designates the asexual reproduction of *Microstoma* (as also that of the *Naidæ*) simply as fission.

In 1849 M. Schultze declared very emphatically that the multiplication of the Microstomids, like that of *Nais*, "depends not upon a mere formation of buds, but upon a constriction of a single animal into several, progressing according to perfectly definite laws" †. Like Schmidt, Schultze also herein attached most importance to the fact that "in this there takes place an actual separation of a portion previously belonging to the parent to form a new individual" (*loc. cit.* p. 294).

Von Graff, in his 'Neuen Mittheilungen über Turbellarien' (1875), in which we find the first exact description of the asexual reproduction of *Microstoma*, regards the process as fission, without making any further observations on the point ‡.

Von Graff's results were supplemented, in some cases rectified, by the important investigations of P. Hallez, in particular by the discovery that it is always the posterior third of the body of the multiplying animal which represents the rudiment of the new zooid §.

Von Graff was subsequently able to confirm this discovery, but it induced him, in his great Monograph of 1882, to declare the multiplication of Microstomids to be a case of gemmation. The following sentences || convey the essence of his view:—"The . . . asexual reproduction of *Microstoma lineare* is undoubtedly to be regarded as gemmation, and indeed as a terminal formation of buds, in which the posterior end of the parent 'grows and separates itself off as a young individual from the old,' so that therefore "the younger terminal bud" is "subordinate to the older parent individual."

"It was not until Hallez discovered the fact that it is always only the posterior third or fourth of the parent, therefore that portion which we may as it were regard as the

* O. Schmidt, 'Handbuch der vergleichenden Anatomie,' 8 Aufl., Jena, 1882, p. 107.

† M. Schultze, "Ueber die Fortpflanzung durch Theilung bei *Nais proboscidea*," Arch. f. Naturgesch. 15 Jahrg. Bd. i. p. 294.

‡ L. Graff, "Neue Mittheilungen über Turbellarien," Zeitschr. f. wiss. Zool. Bd. 25, pp. 409 et seq.

§ P. Hallez, 'Contributions à l'histoire naturelle des Turbellariés,' Lille, 1879, pp. 153 et seq.

|| L. v. Graff, 'Monographie der Turbellarien.—I. Rhabdocelida,' Leipzig, 1882, p. 174.

increase due to growth over and above the limits of the individual, which separates off from it, that the character of this reproduction as a process of terminal gemmation was made plain. That it is a case of terminal gemmation with which we have to deal is emphasized even more definitely by the fact that the parent, however many buds it may produce, never decreases in size. On the contrary, the size is always equal to that of solitary individuals, which I have observed before the appearance of any indication of budding, or at the very commencement of it. . . ."

This view has hitherto met with much approbation.

Yet opposition, though indeed more of an occasional kind, has also been meted out to von Graff's gemmation theory.

Thus Count Zeppelin, in his paper on *Ctenodrilus monostylus* * (1883), observes:—"The erroneous view previously held, that reproduction by fission in the Worms depends upon mere gemmation, has been overthrown by O. Schmidt for the Microstomids, which belong to the Rhabdocoele Turbellaria, since in these animals there takes place an actual separation of a portion previously belonging to the parent. The incorrectness of this theory is similarly proved by the processes of fission which are found in *Nais*, *Chaetogaster*, *Ctenodrilus*, &c., in which the hindmost section of the body passes unchanged into the new creature. In these animals a genuine fission occurs, while in *Autolytus*, *Filograna implexa*, *F. Schleideni*, *Myrianida*, and others the young individuals sprout forth as buds upon the parent form without including in themselves integral constituent parts of the latter. In this case therefore a true gemmation takes place."

Count Zeppelin therefore agrees with O. Schmidt and M. Schultze in regarding the direct transition of a portion of the parent into the daughter individual as the crucial test of fission.

It is essentially from the same point of view that Goette, à propos of his investigations into the ontogeny of *Aurelia aurita*, pronounces the reproduction of the animals which we are discussing to be a process of "successive fissions" †.

Claus, too, in the different editions of his well-known manual, always treats the asexual reproduction of *Microstoma* substantially as (transverse) fission, although it is true no great weight can be attached to this, since this author by no

* Graf Zeppelin, "Ueber den Bau und die Theilungsvorgänge des *Ctenodrilus monostylus*, nov. spec.," Zeitschr. f. wiss. Zool. Bd. 39, p. 645.

† A. Goette, 'Entwicklungsgeschichte der *Aurelia aurita* und *Cotylo-rhiza tuberculata*,' Leipzig, 1887, p. 48.

means makes a strict distinction between fission and gemmation (*cf.* note *a*, below).

The above historical sketch, all incomplete though it is, renders sufficient evidence of the uncertainty which blocks the way of an absolute criticism of the reproduction of *Microstoma*; so that in spite of the material progress which has been effected in our knowledge of the process since the investigations of Schmidt, the theoretical interpretation of the subject (like that of many similar processes in other animals, especially worms) appears to have been in no way advanced.

This surprising state of things is due not so much to the peculiar phenomena presented by the asexual reproduction of *Microstoma*, as to the general fact that uncertainty has arisen as to what is to be regarded as fission and what as gemmation. This uncertainty, it is true, appeared latterly to have been abolished by the view, which met with constantly widening acceptance, that fission and gemmation are processes which are most intimately related to one another. As a result of this the question whether in a particular case this or that interpretation was correct naturally lost its importance (note *a*).

Nevertheless the view which maintains that fission and gemmation are fundamentally only two different representations of one and the same form of reproduction does little more than clothe the old uncertainty in a new garb; for if we would discover relations of whatsoever kind between fission and gemmation we must first have come to an understanding as to the essential characteristics of the two reproductive methods. Yet every one who is acquainted with the subject is aware how little this condition is fulfilled at the present time. The manuals are lacking in precise statements*; in particular cases we help ourselves by distinguishing, *e. g.* in the Syllidæ and their allies, a "fissiparous" from a "gemmaiparous" reproduction, or by paraphrasing so-called

a. Thus the question whether the strobilation of the Medusæ is to be regarded as simple transverse fission or as terminal gemmation appears to Claus "to be in itself a case of splitting hairs."—C. Claus, 'Untersuchungen über die Organisation und Entwicklung der Medusen,' Leipzig, 1883, p. 17.

* The present paper was practically completed when I came across Heft 2 of Hatschek's 'Zoologie.' The observations of this author upon fission and gemmation contain a wealth of appropriate standpoints for the consideration of the question, and I hasten to refer the reader to them, at any rate for the sake of comparison, since a detailed discussion of his remarks would here lead us much too far afield, considering the difference in our fundamental ideas of the processes (*cf.* Hatschek, 'Lehrbuch der Zoologie,' Heft 2, Jena, 1880, pp. 216 *et seq.*).

"terminal gemmation" as "growth in the longitudinal axis with subsequent transverse fission"*, &c.

To proceed to generalizations before we have acquired complete clearness as to fundamental notions is always a critical undertaking. I therefore hold it to be absolutely indispensable, though other investigators may perhaps at once consider it superfluous, to find out what we are to term fission and what is to be designated as gemmation.

Since I was thus of necessity led, from the interpretation of the reproduction of *Microstoma* in particular, to a general investigation of the doctrine of fission and gemmation in the whole Animal Kingdom, a simple consideration indicated the path which I had to adopt for the latter. It was self-evident that it was not a question of somehow or other distinguishing fission and gemmation from one another, but of demonstrating the natural characteristics of the two forms of reproduction, or at least of one of them. "Natural" characteristics are, however, those which, in the notional meaning of the term, which is also otherwise united therewith, admit of being enumerated without compulsion.

The word "gemmation" denotes exclusively biological processes, to which there is nothing corresponding outside organic nature. Nevertheless, owing to the multifarious and consequently ambiguous application of this expression, it is absolutely impossible to state what gemmation signifies within the limits of the Animal Kingdom. In one case tentacles "bud" upon a polyp, in another proglottids from a scolex, in a third segments at the growing hinder end of an Annelid, or, again, whole individuals or parts thereof "bud" from and upon a parent, and in the ontogeny of Vertebrates we even meet with a "caudal bud." The only feature in common which all these different processes can well have is that *something, somewhere and somehow, grows upon an animal.*

I therefore reverted to "fission," a word with which everyone connects a distinct idea, which is first acquired outside the vital processes. This gives us an objective foundation for further developments.

The following statements therefore proceed from the starting-point of fission. I have put them as shortly as possible, because I did not wish to prolong the present paper to an unseemly length.

Whether the attempt which I have made to establish a

* C. Claus, 'Untersuchungen über die Organisation und Entwicklung der Medusen,' Leipzig, 1883, p. 17.

natural conception in the doctrine of asexual reproduction by gemmation and fission in the place of the confusion and arbitrary interpretations which have hitherto existed will meet with any approval among my fellow scientists the future will decide; it would be enough for me if a stimulus should thereby be given which shall cause better insight and more comprehensive information than I myself possess to win a knowledge of the truth.

II.

According to the meaning of the word, "fission" signifies the simple separation of one (or more) portions from an integral whole, therefore the division of an originally united whole into two or more parts. If we cut a block of stone into three portions we effect a fission: the process of separation itself is the fission. Herein it makes no difference whether the sections which now exist are of the same size or not and whether they were actually produced simultaneously or one after another. If for the block of stone I substitute a crystal which is *in statu nascendi*, and therefore continually increasing in size or growing, and cut it into three pieces, this is equally a fission. The concurrent increase in size, or growth, does not affect the process; it is a natural property of the crystal and is a normal phenomenon.

The idea conveyed by the term fission as applied to the inorganic body (and as it is also applied in daily life) is thus exhausted with the actual process of division, and is seen to be independent of:—

- (1) The size of the fission products;
- (2) The time of their origin; and
- (3) The presence or absence of a normal increase in size (growth).

In order to be able to transfer to organisms the conception of fission which we have gained, an appeal might be made to the fact that people have been induced to designate as fission certain forms of reproduction in animals, precisely because they corresponded to the usual interpretation of this expression. But if, among the asexual modes of animal reproduction, we should succeed in finding one (or more) which would admit of being classed as fission without straining the limits of the conception as enunciated above, not only would the intended transference be justified thereby, but

also a starting-point would be gained in the Animal Kingdom itself from which we could criticize other methods of propagation; for we should still have to separate the material in them from the immaterial and to distinguish the primary from the newly acquired.

Among the Metazoa such an attempt is useless, since even the least complicated form of asexual reproduction which occurs in this group, the simple breaking up of *Lumbriculus*, exhibits phenomena (regeneration) in connexion with the multiplication which at once exclude the possibility of identifying the process with the fission of inorganic bodies.

With regard to the Protozoa the case is different: here we actually find the desired starting-point. The fission of an *Amœba* coincides exactly as regards the outward phenomenon and its consequences with that of the block of stone or crystal: the process itself and the relations to size, time, and growth are the same in each case. The only difference is objective and does not affect our argument; it lies in the fact that the effect, which in the case of the block of stone is produced by the hand of man from the outside, results in the *Amœba* from internal causes having their origin in the organism itself.

Since, therefore, both instances of fission are similar processes, the fission of the *Amœba* also consists in the actual process of division. I will term this simplest form of fission, which we may also hold to be the earliest, "*architomy*" (i. e. "*primary form of fission*").

Nevertheless among the modes of reproduction found in the Protozoa there are also some which appear to diverge considerably from the architomic type, and yet from the earliest times they have been declared without contradiction to be instances of fission. We will briefly consider two of these cases.

The reproduction of certain Infusoria takes place in such a way that an envelope or cyst is differentiated within which the processes of fission are carried out. The latter, considered by themselves, belong to the architomic class; but in connexion with them we get the further phenomenon of the above-mentioned formation of the envelope. Clearly the true question which is here raised is this: Is the formation of a cyst the expression of a new principle, when contrasted with which the fission becomes of secondary importance, or may we interpret it as an adaptation of one of those vital phenomena otherwise known to us in these animals, which is here brought into harmony with and subordinated to the process of fission? There never was any doubt about rejecting the

former and accepting the latter of these hypotheses. We justly regard the secretion of a cyst as a protective formation secondarily acquired and owing its origin to the existence of fission.

The majority of Infusoria, such as *Stentor* for instance, preserve their species by means of a form of fission in which the formation of a new peristome and pharynx is to be observed in one of the two animals in process of development. Phenomena of this nature, which we shall meet with in the fission of higher animals of all kinds, have long been included under the term "*regeneration*." The question which we put in the case of cystic fission leads to a similar answer when applied to the mode of reproduction found in *Stentor*. The regeneration of the organs which we have mentioned does not imply something fundamentally new, but is a consequence which necessarily results from the organization of the dividing animal, the effect of which is to enable the posterior zooid to maintain an independent existence. It is easy to see from the context that in the case of the anterior fission-product, which is from the first in possession of the original structures and therefore of the conditions of an independent life, no, or, to be more exact, scarcely any, regeneration is necessary.

The examples which have been adduced show that certain forms of fission in the Protozoa include accessory processes, among which the phenomena of regeneration at least are seen to be *necessary*, and in many cases of fission must attain the importance of a *conditio sine quâ non*. In consequence of this, however, that which in the case of the *Amœba* is effected by the fission, the actual process of division—originally a form of reproduction in itself—becomes in the case of *Stentor* a stage in the fission of this Infusorian, which is also characterized by regeneration. The latter mode of reproduction, therefore, when contrasted with that of *Amœba*, signifies a higher and more advanced form of fission, and may be designated as "*paratomy*" (i. e. "*secondary form of fission*"), as opposed to architomy. The process of division, which is the essence of architomy, appears as a stage in paratomy as "*dissection*" or "*separation*."

I now proceed to the consideration of another mode of reproduction among the Protozoa, namely gemmation. The multiplication of *Podophrya* may serve as an example.

We are here confronted with a phenomenon which is not to be understood from the ensemble of the points of view which we have adopted for the consideration of fission, and is therefore virtually new: this is a *special kind of growth*. While in the case of *Amœba* and *Stentor* the increase in size,

which happens to take place concurrently with fission and which I previously neglected for the sake of simplicity, offers no peculiarity, the growth which leads to the formation of a bud in *Podophrya* differs from the very first from the normal increase in size in this Acinetarian. The growth of the Acinetarian buds is limited in extent to isolated spots on the surface of the body of the budding parent-form: *it is not the growth of the Podophrya, but a growth upon it, by the side of which the former continues, or may continue, to exist.*

It is advisable, for the sake of simplifying matters, to sharply distinguish this bud-growth under the title "*differential*" from the normal or "*individual*" growth.

Differential growth appears to a certain extent as transcending the organization and personality of the budding parent-form, and therefore implies no increase of size for the latter; precisely on this account it necessarily leads to the production of a new individual: *in its simplest form* it in no way affects the organization and individuality of the budding animal, as, for instance, is manifest in the case of *Hydra*. As opposed to this, *individual* growth entails an actual increase in the size of the animal which is sooner or later to divide; but this coincides with the form of growth which belongs to this organism, since it actually represents nothing more than the natural increase in size (*normal* growth) of the creature in question, whether simultaneously or subsequently asexual reproduction sets in or not.

In this connexion also I would at the same time emphatically point out that it is not the direction of growth which constitutes the entire difference, as it might appear on a superficial consideration of the circumstances of asexual reproduction. As a matter of fact the buds of Acinetarians also make this clear, since their growth essentially takes place in the normal direction of that of the parent, and yet in no way represents a simple increase in the size of the latter.

The multiplication of Acinetarians thus proves itself to be a form of reproduction which differs from fission, and is *in its essence solely and sufficiently determined by the appearance of a special form of growth, which we have termed differential.* This peculiarity is certainly important enough to warrant our designating such processes by a special name: I merely follow old custom in embracing them under the comprehensive term "*gemmation.*"

That which reminds us of fission in these cases is simply the process—the severance—by which the bud becomes a free independent being, an act within this asexual mode of reproduction, which is far more often omitted than performed,

whereby its subordinate importance appears sufficiently established (formation of colonies in Metazoa).

Although I have hitherto spoken of the Protozoa, it was far from my intention in so doing to pronounce judgment upon the forms of reproduction in these animals, which so greatly overlap one another, especially since scarcely anything can be added to the classic statements contained in Bütschli's great work; it is, on the contrary, more in accordance with the plan of these explanations briefly to consider, by the aid of a few characteristic examples, reproductive conditions of the simplest kind, which are not without value for the comprehension of the asexual propagation of the Metazoa. The following arguments refer solely to the Metazoa, and claim validity for these alone. I therefore think it desirable, since I consider a sharp separation of fission from gemmation to be possible for the higher animals, and shall exert myself to accomplish the same, to declare emphatically at this point that as regards the Protozoa I side unreservedly with those who hold that fission and gemmation merge into one another in these simplest forms of animals, and who therefore decline to draw a strict distinction between them within this branch of the Animal Kingdom. In this connexion it will be readily understood that in proceeding with the views which we have just acquired to the domain of the Metazoa I do not wish to convey that the fission and gemmation of the higher animals are to be referred phylogenetically to the similarly named processes in the Protozoa.

At the gate of the Metazoon kingdom stands the so-called *process of segmentation* (fission of the ovum). Although this has no direct relation to asexual reproduction, it will nevertheless be useful for our purpose to bestow a brief consideration upon it.

The segmentation of the ovum has invariably and without contradiction been regarded as fission, even where "so typical a picture of gemmation is exhibited as can only be presented by an Acinetarian among the Protozoa"*. It is clear that "if from certain large cells there actually grow out small portions, which are gradually constricted off"*, such a process, provided it really takes place, coincides far more with the idea of gemmation than with that of fission. In spite of this we speak even in such cases, and rightly, of a fission of the ovum, since the growth which thereby appears is the normal growth for the ovum in question, and must indeed be

* J. v. Kennel, 'Ueber Theilung und Knospung der Thiere,' Dorpat, 1888, p. 11.

so, since it does not possess any other kind. The essence of gemmation, however, lies precisely in this, that the growth peculiar to it is added as a new process to the normal phenomenon.

Moreover, no matter what views we may hold as to the evolution of the Metazoa from the Protozoa, we are bound to recognize in the fission of the ovum a recapitulation of the typical fission of the Protozoa, which thereby passes from a form of reproduction into a mode of multiplication for tissues.

The segmentation of the ovum thus teaches us that the expression fission is also applied in the same sense outside the phenomena of reproduction.

For the investigation of reproduction by fission and gemmation in the Metazoa the course which we adopted in the case of the Protozoa is impracticable for obvious reasons. I shall therefore in the first place attempt to gain standpoints for a general consideration of the question, and in so doing briefly refer to concrete examples only where it is necessary.

The cases of asexual reproduction by fission and gemmation which have so far been discovered in the domain of the higher animals admit quite well of being connected with the similar conditions which exist among the Protozoa.

Firstly with regard to fission: the modifications of the original form of fission, architomy, which arise among the lower animals, undergo extensive development in the Metazoa. The higher stage of organization existing in these animals entails the impossibility of architomy in their case; the processes of regeneration which are connected with almost all cases of fission among the Metazoa cause those modes of reproduction to appear rather as instances of paratomy when contrasted with what happens in the case of *Stentor*.

In the fission of the higher animals *three* stages may be distinguished, which both in themselves, as also in their relation to one another within a case of paratomy, require more detailed discussion. They are, firstly *regeneration*, secondly *separation (dissection)*, and thirdly *growth*.

That the *regeneration* which in the case of *Stentor* combines with the separation to form an harmonious whole must in the Metazoa advance into the foreground in proportion as the organization of the proliferating animals becomes more complicated, is so natural a circumstance that we should be surprised if it were otherwise.

Now as the measure of the work to be performed by regeneration in organs and parts of organs, which must necessarily be reconstructed, becomes constantly greater, it is self-evident that the process of separation will sink in the

same degree in the outward manifestation of the fission, until at last it assumes the position of a more secondary final act.

There is a natural inclination on the part of the observer of this class of fission to regard the extensive reconstructions as the essence of the process, while considering as of trifling moment the uninteresting separation.

It is, however, other things being equal, not so much the extent as the nature of the regenerations which causes many cases of fission to be interpreted as gemmation. Thus gemmation is especially discovered in all kinds of worms, whereas, so far as my own conviction goes, in these animals, with perhaps the sole exception of the remarkable reproduction of *Syllis ramosa*, with which M'Intosh has made us acquainted*, fission alone occurs.

For, on observing the course of the regenerations, manifold features are seen, which are found in the formation of a number of organs in the ontogeny of many animals, and which we are wont to term in ordinary phraseology "sprouts" or "buds." Of the extent to which this outward similarity of what are at the bottom very different processes is taken as internal homogeneity, owing to the consonance of their designations, the Naids are a classic example. The gemmation which is alleged to exist among these worms reduces itself to the appearance of so-called "zones of gemmation" in their asexual reproduction. Herein it must remain undecided whether this multiplication is to be regarded as "gemmation," because "zones of gemmation" are formed, or whether, on the contrary, these latter receive their designation because the whole process is to be taken as an instance of gemmation. The "zones of gemmation" of the Naids are, however, nothing more than *zones of regeneration*, within which proceeds the development of organs and parts of organs, which is necessarily combined with paratomy. That the latter is an actual new formation is in accordance with the nature of the case; it is related to the fission of the Naid in precisely the same way as is the formation of peristome and pharynx to the reproduction of *Stentor*. If, therefore, we speak of such processes as fission depending upon "gemmation" or "processes of gemmation"†, we do not use the expression "gemmation" in the sense of the mode of

* "Report of the Scientific Results of the Voyage of H.M.S. 'Challenger,' Zoology," vol. xii. pp. 198 *et seq.*

† Thus, according to Vogt and Yung, the asexual reproduction of *Microstoma* consists "of repeated transverse fissions, and proceeds from axial budding at the posterior end" (C. Vogt and E. Yung, 'Lehrbuch der praktischen vergl. Anatomie,' i. p. 284, Braunschweig, 1888).

reproduction defined thereby, and consequently are not entitled to consider the two ideas as equivalent to one another. It would be more correct and would help to avoid erroneous conceptions were we to abandon the word "gemmation" altogether in such a sense, and simply designate the new formations as what they actually are, namely regenerations.

That the so-called zones of gemmation really deserve to be criticized in this way is most clearly shown by the cases in which such localized zones do not appear at all for the new formations which are necessary. This is seen in *Microstoma*, for example; quite peculiarly characteristic, however, is the different behaviour of the two species of *Ctenodrilus*, therefore of two Annelids which are most closely allied; in the case of one of these, *Ctenodrilus pardalis*, fission is ushered in by the appearance of the rudiment of a zone of regeneration*, while in the reproduction of the other such a process is absent, and the regenerations only proceed after the zooids have attained their independence†. *All these processes of new formation are the same in principle*, no matter whether they are accompanied or not by the development of special zones of regeneration.

The fission of *Haplosyllis spongicola*, however, which has been closely investigated by Albert, proves that the regenerations, and therefore also the special kind of them, can in themselves in no way determine the character of a case of asexual reproduction; for in the Syllid in question the "swimming buds," as they are called, which are detached and contain the sexual products, do not reproduce a special cephalic somite at all, but rather give rise to quite differently constituted new formations throughout their entire organization, so that the form and structure of these swimming zooids appear to diverge very considerably from that of the primary form‡. In this connexion mention must moreover be made of *Clistomastus*, a Capitellid in which, as Eisig has informed us, the abdomen is constricted off filled with the ripe sexual products, although in these genital zooids neither new formations, as in *Haplosyllis*, nor regenerative processes appear, so that they represent extremely incomplete persons—so to speak

* J. Kennel, "Ueber *Ctenodrilus pardalis*, Clap.," *Arbeiten a. d. zool.-zoot. Inst. in Würzburg*, Bd. 5, pp. 395 *et seq.*

† Graf Leppelin, "Ueber den Bau und die Theilungsvorgänge des *Ctenodrilus monostylus*, n. sp.," *Zeitschrift f. wiss. Zool.* Bd. 39, pp. 635 *et seq.*

‡ F. Albert, "Ueber die Fortpflanzung von *Haplosyllis spongicola*, Gr.," *Mitth. a. d. zool. Stat. zu Neapel*, Bd. 7, pp. 10 *et seq.*

mere genital tubes*. Similar conditions are also presented by the fission of the *Scyphostoma* (*Strobila* formation), in which the fission-products which successively arise are transformed from the original tentacle-bearing form into the lobed stage of the *Ephyra*.

The process of *separation*, as has already been stated, when contrasted with the more or less comprehensive regenerations, recedes in the same ratio into the background, especially where the paratomy is still further complicated by vigorous growth. As a rule separation constitutes the conclusion of fission, so that the development of the zooids which are set free is essentially complete. Occasionally, however, it ushers it in, as is partially the case in *Ctenodrilus monostylos*, but is especially seen in *Lumbriculus*. Von Kennel† has laid stress upon this condition, as he is moreover inclined to regard the fission of *Lumbriculus* not as a mode of reproduction, but as a simple augmentation. Nevertheless the observations which have been published by Bülow‡ tend in one way rather to confirm the former view, though beyond this no special importance can be attached to the occurrence of so-called raw surfaces ("Wundflächen"), since these appear, although in a limited degree, in many cases of fission, and in fact are usually quite unavoidable. In *Microstoma* itself, for example, it is easy to convince ourselves that not infrequently quite a considerable raw place is to be seen, so that a destruction of tissues takes place at the spot.

With regard to *growth* it is to be remembered that it may accompany fission in so far as the growth is a property of the individual. The only question to be decided therefore is whether in a particular case the growth is individual or differential. Such a distinction is *at all times practicable* as soon as we grasp the fact that the bud, as such, proceeds from differential growth. I make this observation in opposition to the objection, improbable though it be, that the regenerations which have been discussed above arise in the same way.

The essential feature of gemmation-growth lies in its peculiarity of producing new individuals by being added to the normal growth; that it is also a growth which is confined to definite spots on the surface of the body of the parent form,

* H. Eisig, 'Monographie der Capitelliden des Golfes von Neapel &c.,' Berlin, 1887, pp. 794 *et seq.*

† J. v. Kennel, 'Ueber Theilung und Knospung der Thiere,' Dorpat,

‡ C. Bülow, "Ueber Theilungs- und Regenerationsvorgänge bei Würmern," Archiv für Naturgesch. 49 Jahrg., Bd. 1, p. 28.

and is therefore local, is undeniable; *but it is not every instance of local growth that signifies gemmation.* It is necessary to exclude, firstly those regenerations which are localized upon zones of growth, and secondly the large number of processes of growth which, whether it be in consequence of simple elongation, or whether it be due to actual increase in bulk, are hereby restricted to an axis of the body (longitudinal axis). This course involves nothing that is arbitrary, but is rather a consequence of a logical necessity, since that increase in size represents the normal form of growth of the Metazoa in question and *takes place even in those cases where no asexual reproduction is combined with it.*

As regards the mutual relations of regenerations, separation, and growth in the course of a case of paratomy, I have already mentioned the variation which occurs in the time of the appearance of separation. With reference to this we might distinguish cases of paratomy with precocious regenerations from those in which they are of subsequent occurrence, were it not for the existence of the difficulty which is due to the fact that in many cases separation sets in when the first stages of the new formations have already commenced.

The relation in time between the regenerations and growth is here of special interest for us. In this respect the fission of the Naids is perhaps the most instructive and may serve as an example.

In the first place the growth of the Naid in process of fission appears everywhere as segmental and restricted to the longitudinal axis of the body of the animal, as is typical for the segmented worms; it is therefore an individual growth. But the extent of the increase in size, which is for the time being attained by the fission-products which are in process of formation, varies greatly, owing to the fact that the regenerations, that is the zones of regeneration, already appear before the growth of the zooids which are originated thereby has developed a trunk-section of any size (reproduction from the anal somite); or, in other words, that the point of time at which the rudiments of the zones of regeneration are developed appears to be transferred to constantly earlier stages in the size and therefore in the development of the future zooids. In consequence of such accelerations it is easy to form the impression that the fission-product grows out as a bud from the parent form. In connexion with forms of paratomy in the Naids which run a more regular course, however, these alterations in the order of time will become of so much

the less importance, since *the various processes themselves are the same in all cases.*

This conception of the reproduction of the Naids applies in corresponding fashion to the asexual reproduction by fission not only of the Annelids, but of the Worms in general, for there is no room for doubt that those modes of propagation are essentially of the same kind.

Now if an animal begins to divide and the regenerative processes in the zooids thus produced are quickly completed, and if, moreover, fission again sets in in the zooids themselves before they have attained their independence by means of the separation which is the concluding stage of the primary fission, the result naturally is a formation of temporary colonies, or, to speak more precisely, chains, since we are dealing with the transverse fission of animals which grow in their longitudinal axis. *The precocious commencement and retarded conclusion of fission, concurrently with rapid growth of the dividing animals,* are the circumstances which are chiefly responsible for the complicated and often very peculiar manifestations which are exhibited in the course of the asexual reproduction of many Metazoa. It is true that *secondary* causes are often added to these, since reproduction by fission may combine with transformations of the fission-products (strobilation of the Medusæ) or become more or less subservient to favourable sexual reproductive conditions; *this may result in the omission of regenerative processes and the occurrence of effective new formations* which did not belong to the original animal, but are of great service for the special purposes of the fission-products. An example of this is presented by, among others, the swimming zooids of the already mentioned *Haplosyllis*, which, in order to ensure the widest possible distribution of the sexual products, have equipped themselves with an exquisite locomotor apparatus*.

With regard to *gemmation* a few words only are necessary, for its character lies exclusively in the peculiarity of differential growth, so that all instances of gemmation, no matter whether we have to deal with a Polype, a Bryozoon, or a Salp, agree in this, though diverging widely in the details of the process. It is in consequence of this simplicity in the nature of gemmation as opposed to fission, which in many respects is subject to manifold changes, that the very different phases of development in which gemmation confronts us nevertheless invariably exhibit the same characteristic of special growth.

* F. Albert, "Ueber die Fortpflanzung von *Haplosyllis spongicola*, Gr.," Mitth. a. d. zool. Stat. zu Neapel, Bd. 7, pp. 12 et seq.

It follows as a matter of course from what has been stated that gemmation by no means excludes the direct transition of a portion of the parent into the rudiment of the bud. As a matter of fact this actually occurs in the reproduction of certain Stony Corals, for an account of which we are indebted to the beautiful investigations of von Koch*.

In the foregoing statements as to fission and gemmation I have, in order to avoid too great complication of the progress of the discussion, disregarded a circumstance which nevertheless requires to be shortly considered in order to complete the views which we have gained, *i. e.* the question of *individuality*.

Hæckel was probably the first to establish the fact that, contrary to what happens in the case of fission, which disposes of the original parent-form, the individuality of the bud-producing animal is preserved unaltered. The general truth of this proposition is beyond question; in the case of gemmation it is proved by experience, in that of fission it is *à priori* a logical necessity. Nevertheless it appears to me to be desirable to trace the change of individuality, at least in the case of those "successive" fissions (*strobilation-form of fission sensu latiori*) which are of such frequent occurrence. In so doing I have no intention of entering at length into the theory of animal individuality; on the contrary, it is sufficient for our purpose to proceed from more general experience and considerations.

Starting from the fact that in many animals "the single individual can be split up by means of artificial division into several individuals which continue an uninterrupted existence," it was shown by Goette "that this divisibility is neither unlimited nor unconditional, but is without exception accompanied by the fact that the parts possess the structural conditions of the whole, and moreover the power of preserving them in integral continuity—that, in other words, they are capable of providing in themselves a complete repetition of the original whole; 'individuality' of organisms therefore does not signify absolutely an indivisibility, but rather only such as maintains the integrity of a vital unit or of a common life, and at the same time the possibility of an independent existence"†.

Goette therefore sees in individuality the "condition of

* G. v. Koch, "Die ungeschl. Vermehrung einiger paläozoischer Korallen vergleichend betrachtet," *Paläontographica*, Bd. 29, pp. 341 *et seq.*

† A. Goette, 'Ueber den Ursprung des Todes,' Leipzig, 1883, pp. 12 *et seq.*

certain relations of the parts to the whole ; " this corresponds, however, to the stage which the organization has attained at the time, and is therefore " moreover dependent upon the origin and progress, in short the development of the organization."

This conception applies in the same degree to embryonic development as to reproduction of animals by fission or gemmation. In both cases the individuality of the animal which is coming into existence shows itself dependent upon the progress of the organic development, as a cohesion of definite relations of the parts to the whole, which becomes ever more and more consolidated concurrently with the organization. But naturally it is impossible that this cohesion should be a rigid one, the same for all animals—this is proved at once by the exceedingly variable degree to which the regenerative capacity is expressed ; it will, on the contrary, be extensible within narrower or wider limits. Herein lies the *a priori* difference between fission and gemmation, as well as every other mode of reproduction, since the former necessarily postulates a loose arrangement of that cohesion, more readily dissoluble without injury to the common life ; for were this not so the power of fission would be altogether suspended. The individuality of animals undergoing fission must therefore be of a fusible kind, so fusible that a continual change in the cohesion of the parts which form a whole is rendered possible, without occasioning disturbance to the common life.

Experience proves that in all cases of fission a portion of the original relations existing in the parent form is dissolved, and combines with those which now appear for the first time and which result from the development of new organs by regeneration to form a new unit ; while the remnant of the old relations which is left behind either manifests by itself a unity which is viable or replaces the relations which have been lost by equivalent new formations. Thus, in *Microstoma* an animal divides in the first place into two individuals, whereby the original individuality is destroyed and superseded by the two new ones. The latter soon experience the like fate, and with the destruction of their individualities four fresh ones are constituted, and so on.

It is impossible to raise the objection that perhaps they are quite unimportant and trivial portions which are taken from the original animal and applied to the formation of one of the new individuals, and that therefore the individuality of the other zooid is essentially unchanged, since, indeed, it remains

in possession of the most important primary organs (central organ of the nervous system &c.); for the proportion of the original relations which are dissoluble is indeed limited by the conditions of the permanence of the common life, but within these limits is free, now greater, now smaller. Whether the posterior half or the posterior quarter or eighth of a *Microstoma* forms a new individual of itself is a matter of complete indifference for the character of the entire process. In other words, the division of a *Microstoma* into two equal halves is fundamentally the same process as its fission into two products, one of which consists of three quarters and the other of one quarter of the original animal, and so on.

A series of separate acts of fission, as exhibited by the species of *Microstoma* for instance, is in ordinary terminology usually referred to one animal as the mother-individual ("ancestress" ("Stammutter") of von Graff); and if a number of units has been developed we are accustomed to say that the "ancestress" has given rise to so many daughter individuals. We are the more inclined to do this since separation sets in very late, so that the zooids remain for a time in connexion with one another and form temporary chains of individuals.

This view is, however, strictly speaking erroneous, for the ostensible "ancestress" is destroyed by the very first fission, and for the following one the two zooids which resulted from the first paratomy behave to their products as "ancestresses," precisely in the same way as their parent form did to them, and so on.

If therefore we say that the *Microstoma*-chains have arisen simply through fission we must be understood only to mean that these chains owe their origin to a series of paratomies, in which the final acts, the separations, appear postponed in regular sequence to relatively late periods. The reproduction of *Microstoma* therefore represents a combination of successive acts of fission, each separate one of which constitutes a paratomy.

From the standpoints which have been developed in the foregoing paragraphs, I would define fission and gemmation in the Metazoa as follows:—

Fission is a process of separation of parts which originally belonged to an integral whole, and have arisen or are in process of origin by normal growth, wherein new individuals are formed by supplementary new formations, with destruction of the original unit.

Gemmation, on the contrary, is a process of new formation

of entire individuals, depending exclusively on a peculiar (differential) growth, which differs from the normal; herein the budding vital unit is usually preserved unchanged.

III.

I have no intention of here discussing separately the cases of reproduction by fission and gemmation which have been discovered up to the present time among the Metazoa. After what has been stated in the previous section there can scarcely be any necessity to do so, more especially since a series of instances of asexual reproduction, like that of the Tunicates, Bryozoa, and most of the Coelenterates, is universally and without contradiction regarded as gemmation.

It is true that the case is different as regards the so-called *terminal gemmation* (formation of buds at the end, *strobilation sensû latiori*=*axial gemmation* of von Kennel*), under which are included the formation of *Ephyræ* in the *Medusæ* (originally *strobilation sensû stricto*), certain forms of reproduction in the Stony Corals, more closely characterized by Semper†, the formation of chains in the *Microstomids* (*Microstoma* and *Stenostoma*), and lastly the majority of modes of reproduction in the *Annelids*‡.

Nevertheless even in these cases there is no further need for any detailed statements if I affirm that the above processes of asexual reproduction are instances of fission.

For as regards the *strobilation* of the *Medusæ*, in the first place, the two latest and most exhaustive investigators of the subject, Claus and Goette, have conclusively proved that herein, *even according to the customary method of representation*, fission, and not gemmation, takes place.

"For the proper comprehension of the phenomena of *strobilation*," writes Claus §, "it is before all things neces-

* J. v. Kennel, 'Ueber Theilung und Knospung der Thiere,' Dorpat, 1888, p. 17.

† C. Semper, "Ueber Generationswechsel bei Steinkorallen &c.," Zeitschr. f. wiss. Zool. Bd. 22, pp. 235 *et seq.*

‡ The formation of proglottides in the Cestodes, which is included here by certain investigators as being likewise a case of "axial gemmation," may well be neglected, for the justification for considering the proglottides as a special generation of sexual animals, developing asexually from the Scolex, and therefore regarding the tapeworm as a dimorphic colony, as was persistently maintained by Leuckart ('Die Parasiten des Menschen,' Bd. 1, 2 Aufl., Leipzig, 1879-1886, p. 342), whose latest disciple is von Kennel (*op. cit.* p. 16), is still very doubtful.

§ C. Claus, 'Untersuchungen über die Organisation und Entwicklung der Medusen,' Leipzig, 1883, p. 16. Even to these statements of Claus I am able to attach but little weight, after what has been already men-

sary to bear in mind the fact that the regeneration of an Ephyra on the oral disk of the Scyphostoma, within the circlet of tentacles belonging thereto, has in no single case been proved. There is no terminal gemmation of Ephyrae on the oral disk of the Scyphostoma-polype; on the contrary, the rudiments of the disks of the Ephyrae are segments of the actual body of the Scyphostoma, which are marked off outside the circlet of tentacles by constriction of the wall of the cup, and are set free as sections of the body."

In opposition to Hæckel Claus insists * that "as a matter of fact the terminal portion of the Strobila which becomes the Ephyra—and for the sake of simplicity we will commence with the simplest and most typical form, that of the monodiscous Strobila—is no product of subsequent growth on the part of the Scyphostoma, but rather the anterior half of the body of the latter, which after previous uniform growth of the trunk of the Scyphostoma has marked itself off by constriction and proceeds to attain its liberty as a segment. Moreover, with the separation of the latter the primary individual, as such, is destroyed and split up into two new individuals, since the posterior individual also represents only a segment of the parent form. Both fission-products are coordinated to one another, for the basal stump, with or without a circlet of tentacles, nevertheless essentially corresponds to a Polype which is equivalent to a Medusa. Both Ephyra and Polype are consequently in their mutual relations comparable to an Infusorian in process of fission, of which only the one segment possesses a mouth and adoral zone of cilia, while the other is as yet without these structures or only exhibits them in course of formation. But should we wish to consider one segment as older than the other, and to subordinate the latter to the former, it would be more just to regard the hinder and less perfect segment as the younger portion, which would then be comparable to a terminal bud. In truth, however, from the point of view of ontogeny, they are both of the same age and equivalent to one another; yet the anterior segment differentiates sooner into a form which becomes free as a Medusa, while the posterior one subsequently undergoes regeneration and completion."

tioned (*cf.* note *a*, p. 26); I quote them, however, in order to show that even those investigators who consider it superfluous to discuss whether we are dealing with fission or gemmation, nevertheless in a given case exert themselves diligently to answer the question.

* *Op. cit.* p. 17.

Goette * expresses himself in a precisely similar fashion:—“Since the first Ephyra-disk is only the further developed oral segment of the Scyphostoma, it naturally follows that it can in no way be regarded as a bud. That which reminds us of gemmation in it, *e. g.* the outgrowth of the circlet of lobes, belongs, just as does the previous outgrowth of the tentacles of the Scyphostoma—both of which processes are indeed termed ‘sprouting’ (‘Hervorknospen’) in looser phraseology—simply to the progressing development of the entire segment, which preserves its identity. It follows that the liberation of the first Ephyra can also be nothing else than the separation of two segments of an organism, both of which are in process of development, but were already in existence before—or, in other words, simple fission. On the abandoned peduncle of the monodiscous larvæ, however, the new Ephyra arises in precisely the same way as the first, by a transformation of what is originally its oral section into the disk of a Scyphostoma, which develops only secondarily into the disk of an Ephyra. For the formation of Ephyrae in the case of the monodiscous larvæ gemmation is therefore entirely out of the question. But owing to the agreement of this process in the case of the mono- and polydiscous larvæ this necessarily applies to the latter just as much as to the former. The disk of the Ephyra therefore never arises by gemmation, and thus strobilation is in all cases a simple fission of larvæ in process of development.”

With regard to the phenomena which immediately succeed the actual separation of the Ephyra from the Scyphostoma, both in the case of the liberated Ephyra-Medusa as also in that of the Polype which is left behind, Goette † remarks that “therein is repeated merely a process of regeneration analogous to that in the development of any other organism with terminal mouth—be it a Worm, Infusorian, or anything else—whereby the general import of the previous or simultaneous process of fission is in no way prejudiced. It is likewise clear that in this respect the regeneration of the proboscis can be of no greater account than that at the gaping crown of the previously liberated Ephyra: both phenomena are inevitable accompaniments of fission, which the development of the first and all subsequent Ephyrae of a polydiscous Strobila cannot exhibit in materially different guise.”

With reference to the supposed instances of gemmation

* A. Goette, ‘Entwicklungsgeschichte der *Aurelia aurita* und *Cotylorhiza tuberculata*,’ Leipzig, 1887, p. 50.

† *Op. cit.* p. 46.

which some years ago were stated by Semper to occur in certain Stony Corals*, it is to be remarked that some of them, in so far as the facts, which were principally derived from the skeletons, admit of such an interpretation at all, must be referred to processes conformable to the Strobilation of the Medusæ, *i. e.* must be regarded as cases of fission. This applies especially to *Flabellum variabile* and *Placotrochus levis*. But as to Semper's statements about the asexual reproduction of his species of *Fungia* (which are not more closely specified), they have so little to do with adequate observations that a close investigation, particularly of the processes of growth as they occur in these forms, will have to be undertaken afresh before a satisfactory insight will be possible.

The numerous modes of reproduction in the Annelids, some of which are more thoroughly, but the greater portion only very superficially, known†, cannot be here discussed. Thus much, however, may be affirmed without immediate proof, that, so far as regards observations and not theories, gemmation has hitherto not been shown to exist with certainty in the segmented worms, with the exception of the peculiar budding form of *Syllis ramosa*. The pretended lateral gemmation of certain Annelids, which Pagenstecher‡ believed he had observed, has already been rejected by Ehlers§ as erroneous. It is true that the asexual reproduction of *Autolytus prolifer*, which was observed years ago by Frey and

* C. Semper, "Ueber Generationswechsel bei Steinkorallen &c.," Zeitschr. f. wiss. Zool. Bd. 23, pp. 235 *et sqq.*

† This applies especially to the reproduction of *Myrianida* (*Myriadina*) described by Milne-Edwards ("Recherches zoologiques faites pendant un voyage sur les côtes de la Sicile," Ann. Sc. Natur. (sér. 3), Zool. t. iii. pp. 170 *et sqq.*). With regard to this M. Schultze says, "As a matter of fact, as is evident from his description, Milne-Edwards observed only a single specimen, which consisted of a series of seven individuals adhering to one another. From the series in question this investigator formulated his views as to the nature of the fission, which he supposed to be based upon a true formation of buds. But how difficult it is to decide from such scanty material, and without the closest microscopical investigation, whether a segment of the parent-form does or does not pass into the young, will be admitted by every one who has occupied himself with similar observations" (M. Schultze, "Ueber die Fortpflanzung durch Theilung bei *Nais proboscidea*," Arch. f. Naturgesch. 15 Jahrg., Bd. 1, p. 302). The numerous and scattered statements as to cases of asexual reproduction in Annelids altogether urgently need a critical sifting, in order to separate the observations from the speculations.

‡ A. Pagenstecher, "Untersuchungen über niedere Seethiere aus Cetta," Zeitschr. f. wiss. Zool. Bd. 12, p. 267.

§ E. Ehlers, 'Die Borstenwürmer,' Leipzig, 1864-1868, pp. 211 *et sqq.*

Leuckart*, but has not since been investigated again, seems to a certain extent to present the appearance of gemmation; yet when considered in connexion with similar processes in the forms most closely allied (*Autolytus cornutus* and the true Syllidæ) it will certainly require another interpretation. Indeed it has been stated by Ehlers precisely with regard to the asexual reproduction of the Syllidæ (including *Autolytus*) "that there is here no question of fundamental differences, but that there merely takes place a development of the same process differing in degree" †. As a matter of fact we ought certainly not to perceive gemmation in the asexual reproduction of *Autolytus prolifer*, but merely an extreme one-sided development of the usual simpler mode of reproduction of the segmented worms.

It is evident from what has been stated that the asexual multiplication of *Microstoma*, which has the chief claim upon our attention in the present investigation, represents fission. That which was demonstrated by Claus and Goette for the formation of Ephyræ is perfectly applicable in all essential points to the fission of the Microstomids also, and it is sufficient to refer the reader to what has been quoted above from the writings of the investigators in question.

Since all forms of reproduction which have been regarded as instances of terminal gemmation thus prove to be cases of fission, we arrive at the result that a formation of terminal buds in the customary sense has no existence whatever.

IV.

I have yet to allude to the statements of earlier investigators.

If we may neglect the more incidental assertions of older authors, E. Hæckel was the first who, although a long time ago, attempted systematically to establish the theory of fission and gemmation. In his classic 'Generelle Morphologie,' so rich in fresh points of view, this investigator wrote (1866): "In self-fission the growth of the individual which ushers in reproduction is total, and in the act of fission is destroyed in its totality, so that the products of fission are equivalent to one another. In the formation of buds, on the contrary, it is an isolated portion of the body of the individual which, by means of special growth, leads to the formation of a new indi-

* H. Frey and R. Leuckart, "Beitrage zur Kenntniss wirbelloser Thiere &c.," Braunschweig, 1847, pp. 91 et seq.

† E. Ehlers, *op. cit.* p. 208.

viduality (bud), and this then separates completely or incompletely from the parent individual without the latter's own individuality being thereby destroyed. Therefore in this case the two products of fission are of unequal value." Hæckel further proceeds to show that fission produces individuals of the same age, whereby the original animal as such is abolished, while the products of gemmation are of different ages, and the budding animal continues to exist unaltered as the parent form*.

These assertions, the artificial construction of which is unmistakable, met with just contradiction on the extension of our knowledge of the processes in question. Thus Goette took the special case of the strobilation of *Aurelia aurita* as the starting-point of a critical excursus, in which he in the first place alludes to the fact that the products of gemmation resemble the parent form far more often than do those of fission. He then goes on to say: "What Hæckel moreover means by the unequal age of the products of gemmation is shown by the application to the case of Strobila which follows upon the heels of the definition; for he says that the disks of the Strobila arise one after the other, and so possess that inequality of age which is the characteristic of gemmation. He therefore refers in this case not to the difference in age between the products of division due to one individual process of gemmation, but rather to the different age of the disks which follow one another in succession. Precisely the same difference of age exists, however, in all successive fissions of the same animal, such as, for instance, appear so conspicuously in *Microstoma*; it is therefore quite useless as a distinctive characteristic of gemmation.

"Just as untrustworthy is, lastly, the characteristic of growth, in the one case total (fission), in the other only partial (gemmation); for, apart from the frequent difficulty of such a distinction, we are in no wise justified by experience in declaring a growth at all to be the necessary cause of every division."

Goette, therefore, is unable to recognize as applicable and sufficient the distinguishing characters of fission and gemmation laid down by Hæckel, and for his part defines fission as a "separation of connected parts, which were therefore already present in a fully developed state," but gemmation as a "new formation of parts by the method of a local growth, which become more or less independent" †.

* E. Hæckel, 'Generelle Morphologie der Organismen,' Bd. 2, Berlin, 1866, pp. 37 *et seq.*

† A. Goette, *op. cit.* pp. 47 *et seq.*

Very recently the customary views upon fission and gemmation, which conform more or less to Hæckel's statements, have also been criticized and rejected by von Kennel, who in so doing arrives at the conclusion "that neither equality or inequality of the products of division, nor difference or agreement of age, nor even the possibility of distinguishing between the original and the new individual, furnish us with the means of separating fission and gemmation" *.

It appears to me to be superfluous to add anything further to the critical statements of Goette and von Kennel, with the results of which I am in accord. As regards Goette's definitions of fission and gemmation which are quoted above, they confine themselves too strictly to conditions which are of importance for the special question of the interpretation of strobilation to suffice for a more general application. I therefore turn to the definitions of the conception of fission and gemmation which have lately been developed in comprehensive fashion by von Kennel.

"If we compare all reproductive processes with one another," says von Kennel, "we find that in one group the mass of the products proceeding from the reproduction, when taken together, is equal to the mass of the original individual before the commencement of the visible changes by which the process was ushered in. In all other cases reproduction is introduced by the appearance of new portions, which have nothing to do with the individual, through an accession of organized substance, so that the sections, after becoming independent, represent in their entirety more mass than was possessed by the original animal before the appearance of the reproductive phenomena. We may term the former class fission, the latter gemmation" †.

It follows from this that von Kennel regards the presence or absence of growth as the sole criterion of gemmation or fission respectively. That in the case of the latter at any rate von Kennel's definition betokens an artificial and arbitrary limitation is manifest without further comment.

But if we follow out von Kennel's assertions to their logical conclusion we arrive at the result that no instances whatever of fission occur within the limits of the Metazoa. For it is impossible to mention any case of asexual reproduction in these animals in which "the mass of the products proceeding from the reproduction when taken together is equal

* J. v. Kennel, 'Ueber Theilung und Knospung der Thiere,' Dorpat, 1888, p. 14.

† J. v. Kennel, *op. cit.* pp. 14 *et seq.*

to the mass of the original individual before the commencement of the visible changes by which the process was ushered in;" because every instance of fission in the Metazoa is, and must be, inevitably combined with regenerations or new formations of another kind. But these just as necessarily entail an increase in organic substance.

Now it is certainly no reason for claiming a process as an instance of fission to say that if we did not fission would entirely disappear as a method of reproduction in the Metazoa. But von Kennel himself designates as fission the asexual reproduction of *Planaria subtentaculata*, which has been described, it is true only imperfectly, by Zacharias*, and has moreover acquainted us with the interesting multiplication of a freshwater Triclad, which he terms "transverse fission," although in both cases, having regard to the regenerative processes which ensue, an increase in organic substance is undeniable†.

Fundamentally von Kennel's conception of fission is exhausted with the bare process of separation, therefore with that which I have termed "dissection" within a case of paratomy. It is therefore postulated by this investigator that, when we would speak of fission in animals, the process in question must be identical with the splitting of a block of stone. This, however, according to animal organization is impossible.

* Von Kennel's conception of gemmation is in no better case. If, as we have seen, practically nothing remained for fission, gemmation, according to von Kennel, includes all instances of asexual reproduction in which any sort of growth appears. It is consequently a matter of complete indifference whether the particular process of growth takes place in the animal as a speciality, leaving the individual manifestation thereof unaffected, or whether it coincides with the normal increase in size of the creature, as we also meet with it in the animal's nearest allies, which, however, lack the faculty of asexual reproduction.

The gemmation of a Salp or Bryozoon, the formation of Ephyra in the Medusæ, the processes of strobilation in the Worms, the gemmation of Hydroids and Corals, &c., are accordingly the same in principle, so much so indeed that, as v. Kennel‡ in the first instance, and, independently of him,

* O. Zacharias, "Ergebnisse einer zoolog. Excursion in das Glatzer-, Iser-, und Riesengebirge," Zeitschr. f. wiss. Zool. Bd. 43, pp. 271 *et seqq.*

† J. Kennel, "Untersuchungen an neuen Turbellarien," Zool. Jahrb. Bd. 3, Abth. f. Anat. u. Ont. der Thiere, pp. 407 *et seqq.*

‡ J. v. Kennel, 'Ueber Theilung und Knospung der Thiere,' pp. 17 *et seqq.*

Lang *, almost simultaneously endeavoured to render probable, all these processes are referable to one and the same starting-point—the regenerative faculty of animals †.

Nothing appears to me to be so characteristic of von Kennel's view of gemmation as the following statements by him ‡:—"There appear . . . in many Annelids, such as *Nais*, *Chaetogaster*, *Æolosoma*, *Syllis*, &c., new structures nearly in the middle of the segmented body, owing to which the anterior and posterior halves of the body are pushed away from one another. If this newly intercalated region of the body differentiates into a larger number of young segments, which further develop partly into new cephalic somites for the section of the body which lies behind them, and partly into new trunk-segments for that which lies in front—it is manifest that a formation of buds is thereby constituted, for in the original individual a new formation has appeared which is at first small, but is nourished by the original form and increases in size. If this bud subsequently constricts more and more about at its middle until complete separation takes place, we can scarcely be contradicted if we term it a case of reproduction by gemmation."

Here, therefore, v. Kennel designates as a bud the "new formation, which is at first small, but is nourished by the original form, and increases in size." This supposed bud, which in truth represents nothing else than the so-called zone of gemmation (zone of regeneration), is no individual at all, no organic person, but a *mixtum compositum*, formed from the posterior and anterior halves of two different animals, attached together by their opposite ends; and for the origin of these two there finally remains no other method after all, except—fission.

Moreover it is at once evident that v. Kennel is here considering cases of fission which, as we are wont to express it, depend upon processes of gemmation, and, designating the special kind of definite regenerative processes as processes of

* A. Lang, 'Ueber den Einfluss der feststehenden Lebensweise auf die Thiere &c.', Jena, 1888, pp. 108 *et seq.*

† From my standpoint I am naturally unable to assent to this view, especially in this generalization. The faculty of reproduction by gemmation and fission and the power of regeneration may certainly depend upon the same general primary causes; but with this nothing is stated as to the special causes, in consequence of which fission has been developed in one case and gemmation in another. The cutting off of a tentacle is, it is true, the external stimulus for its regeneration, but it is not the cause of the power to replace the lost part.

‡ *Op. cit.* p. 13.

gemmation, interprets the whole mode of reproduction simply as gemmation.

When v. Kennel further divides the manifold forms of gemmation into *axial* (strobilation *sensu latiori*) and *lateral**, this distribution is also of little value, since it is based *solely* upon the difference in the direction of the growth, and therefore a similarity of the processes in question in other respects is tacitly affirmed, which is by no means the case. Besides it is in many instances a matter of purely personal interpretation whether the actual bud is regarded as lateral or terminal (origin of many Hydromedusæ by gemmation).

In other words, whether an animal, as such, grows, and during the growth or subsequently divides itself into a number of individuals, or whether an animal by a special growth upon itself produces new zooids, are two entirely different processes; at any rate their difference is far greater than that between the questions whether the buds arrive at their development upon an animal at the side, in front, or behind, provided only that their formation agrees in other respects.

I am therefore not in a position to recognize as really well-grounded the distinguishing characteristics of fission and gemmation which are laid down by v. Kennel, apart from the fact that they also convey no advantage for the praxis of a simpler discrimination between the two modes of reproduction.

V.

On referring to the foregoing statements it may be asserted that fission and gemmation can well be distinguished from one another. While all forms of reproduction which were referable to the natural conception of fission were brought into one division, a general characteristic was disclosed for those methods also which remained outside that series, in the special character of the growth which appears in connexion with them. This separation of two widely distributed forms of asexual reproduction is, however, not to be maintained merely from the practical point of view of facility of systematic survey; but it is also not devoid of a deeper meaning: the intimate relation between fission and gemmation is, at least to the extent to which it is nowadays so frequently accepted, a fiction.

Without of course wishing to deny all connexion between

* *Op. cit.* p. 17.

fission and gemmation*, that conception nevertheless could well have its foundation only in the supposition that not merely do fission and gemmation merge into one another through unequivocal intermediate forms, but that also there is justification for venturing to speak of both modes of reproduction in the general sense; for only on such hypotheses would it be permissible to extend to all cases definite results of the facts found in one or more, and to elevate them into a principle of general applicability.

The conditions alluded to, however, by no means occur.

As regards possible transitional forms, in the first place it certainly appears to be beyond doubt that, especially among the Cnidaria, the existence of such intermediate modes of reproduction cannot be gainsaid. Yet these supposed intermediate forms assume this aspect solely in consequence of the faulty and indefinite character of the views which have hitherto been held. Intermediate forms of this kind occur in the Cnidaria just as little as in the Worms or any other Metazoa. Von Koch was entirely in the right when, on the basis of his minute investigation of the conditions of asexual reproduction, which were, it is true, chiefly those of the Palæozoic Corals, he was induced to create a "fission-gemmation" ("Theilungsknospung"), and included it, as well as his "septal gemmation," under fission, according to customary views†. Yet, according to the aspects which influence me, it is no less clear that, in the forms of gemmation alluded to, I am bound to recognize real gemmation and not fission.

The instances of asexual reproduction in the Worms, in spite of all differences of detail, nevertheless exhibit so uniform a general character as to necessitate similar interpretation. In contrast to these conditions the remarkable gemmation of *Syllis ramosa*‡ appears completely isolated; as yet this represents the sole case of gemmation in the Annelids, and is probably a purely personal acquisition on the part of this Syllid, which has been gained in adaptation to the fundamentally altered mode of life.

* By this I allude not merely to the connexion which is entailed by the community of the same primary causes (cf. last note), but also to that which would, as it were, be implied by the proof that a particular case of fission could, in its origin, be traced to a particular case of gemmation, or vice versa (e. g. origin of strobilation, according to Claus—"Untersuchungen über die Organisation und Entwicklung der Medusen," Leipzig, 1883, p. 18).

† G. v. Koch, "Die ungeschl. Vermehrung einiger paläozoischer Korallen vergleichend betrachtet," *Palaontographica*, Bd. 26, p. 89.

‡ "Report of the Scientific Results of the Voyage of H.M.S. 'Challenger,' Zoology," vol. xii. pp. 198 et seq.

The second point, whether fission and gemmation may be conceived in a general sense, is in no better case. No one will wish to maintain that the various kinds of fission as well as the manifold cases of gemmation have been inherited through the animal series from their first appearance, and should consequently be regarded as phyletic units. But also as regards their origin fission and gemmation cannot have proceeded from the same causative conditions.

From the facts which we have before us an origin of the same kind cannot be exhibited for the series of those modes of reproduction which are to be designated as cases of gemmation; on the contrary, it is in the highest degree probable that the gemmation of the Salps and that of the Bryozoa represent *specific* acquisitions within the respective phyla. Although at the present time no certain decision is possible as to the way in which these acquisitions were developed, nevertheless the wide-reaching investigations of Seeliger have sufficiently demonstrated that the formative laws of gemmation in the Bryozoa are of an entirely different character from those which have had effect among the Tunicata *.

With reference to the quite aberrant gemmation of *Syllis ramosa*, I have already remarked above that the active causes of its origin may well be sought without hesitation in the specialities of its peculiar mode of life.

The cases of gemmation among the Cnidaria are in no way lacking, as it appears, in a more homogeneous character, which may well indicate a common originating cause.

Although it follows that the conditions under which the manifold instances of gemmation may have arisen in the various animal phyla are at present in a great measure still an object of pure conjecture, nevertheless that which is actually known about them in the several cases or series presents results of so heterogeneous a nature that the justification for generalizing about gemmation is at least not proved.

The same applies to fission.

The strobilation-forms of this process in the Cnidaria and Worms, which are usually selected for comparison, have in truth a mere external similarity only. Owing to the great agreement which is exhibited in essential features by all cases of fission in the Worms, we shall have to consider them as a development pointing to a common basis; for this development the conditions of the origin of those modes of repro-

* O. Seeliger, "Die ungeschlechtliche Vermehrung der endoprocten Bryozoen," *Zeitschr. f. wiss. Zool.* Bd. 49, p. 204.

duction were supplied within the phylum of these animals themselves and their peculiar circumstances. In the same way, too, this point of view may well be adopted for the Medusan Strobila also, no matter whether we would derive it with Claus * from the gemmation of stolons or not.

We thus arrive at the final result, that the customary idea of the intimate relationship between fission and gemmation has no justification in facts, but rather that the separation of the asexual reproductions of the Metazoa possesses not only a notional meaning, but also a real foundation.

The cases of asexual reproduction in the various animal phyla have proceeded independently of one another from conditions existing within these phyla, so that that which, it may be, can be rendered probable for a single case of reproduction or for a congeries of similar cases, includes no binding force for other instances of multiplication by fission or gemmation.

It will be the task of future investigation, in determining the originating causes which have decided the character of each form of reproduction belonging to the present category, to separate chaff from wheat, so to speak, i. e. to eliminate from the series of propagations those modes of multiplication which represent mere augmentations. Merit is due to von Kennel for having emphatically drawn attention to this important difference †.

VII.—On some undescribed Cicadidæ, with *Synonymical Notes*. By W. L. DISTANT.

It has been urged, and with some reason, that descriptive papers should, where possible, be confined to the diagnoses of members of some particular zoological region; and if this course could always be pursued the convenience it would afford to purely faunistic workers would doubtless be great. But the formulation of rules and theories is often a very special gift of a very few, and is sometimes in an inverse ratio to possibilities and experience. There is, however, a course which will enable the descriptions of widely distributed insects to be faunistically apprehended, and that is by geographically tabulating the species described in some manner similar to the following, which applies to the present paper.

* C. Claus, 'Untersuchungen über die Organisation und Entwicklung der Medusen,' Leipzig, 1883, p. 18.

† J. v. Kennel, 'Ueber Theilung und Knospung der Thiere,' p. 8.

All the species described are contained in my own collection.

ETHIOPIAN REGION.

Cicada madagascariensis, sp. n. Madagascar.

NEOTROPICAL REGION.

Fidicina amazona, sp. n. Ega.
 — *bogotana*, sp. n. Bogota.
 — *rubricata*, sp. n. Brazil.
Tympanoterpes colombiæ, sp. n. Colombia.
 — *Bergi*, sp. n. Argentine Republic.
Dorachosa (gen. nov.) *explicata*, sp. n. Panama.
Tibicen egæ. Ega.
Tettigades parva. Argentine Republic.

AUSTRALIAN REGION.

Psaltoda flavescens, sp. n. Australia.
Cicada extrema, sp. n. Australia.
Melampsalta labeculata, sp. n. Australia.

PACIFIC REGION.

Kanakia (gen. nov.) *typica*, sp. n. New Caledonia.
Tibicen pumilus, sp. n. New Caledonia.

CICADINÆ.

Psaltoda flavescens, sp. n.

♂. Head ochraceous; the base and lateral areas of front, the area of the ocelli, a broad fascia between the eyes, a central basal fascia, and a linear spot near anterior angles of vertex, black. Pronotum with the disk castaneous, the lateral and posterior margins and a central fascia ochraceous; inner edge of lateral and posterior margins, a central spot on posterior margin, the fissures, and the margins of the central fascia, black. Mesonotum castaneous, with four obconical black spots, the central pair shortest, the outer pair sometimes broken, and a spot in front of the basal cruciform elevation, black. Abdomen above pale castaneous, the anterior margins of the segments broadly blackish, especially on the basal segments, where the markings are centrally macular. Tympanal coverings, excluding anterior margins, blackish. Head beneath, sternum, legs, and opercula ochraceous; the central sulcation and transverse striations to face, space between face and eyes, rostrum (excluding base), coxal streaks, anterior tibiæ, apical halves of intermediate tibiæ, the anterior

and intermediate tarsi, and the inner margin of the opercula, blackish. Abdomen pale castaneous, with the base narrowly black, enclosing two small ochraceous spots.

Tegmina and wings pale hyaline, the venation castaneous. Tegmina with the costal membrane and basal cell pale castaneous; the transverse veins at the bases of the second and third apical areas narrowly infuscated, and a series of small and somewhat indistinct fuscous marginal spots on the apices of the longitudinal veins to the apical areas. Wings with the margins of the claval areas infuscated.

The face is very globose; the opercula do not meet centrally; the rostrum reaches the posterior coxæ.

Long., excl. tegm., ♂ 40, ♀ 30 millim.; exp. tegm., ♂ 107, ♀ 90 millim.

Hab. Australia (no precise locality).

This species is allied to *P. argentata*, Germ., from which it differs by the shape and colour of the opercula, the more globose face, the different colour-markings, &c.

I long possessed an unlocalized female specimen of this species, and have lately acquired a male example from Australia (no definite locality), which has enabled me to describe it.

Cicada extrema, sp. n.

♂. Head and thorax brownish ochraceous. Pronotum with the lateral and posterior margins pale ochraceous. Abdomen above castaneous, the posterior segmental margins paler in hue; apical half of the last segment and the anal appendage ochraceous; tympanal coverings obscure ochraceous. Head beneath and sternum brownish ochraceous; the face, space between face and eyes, lateral margins of prosternum, legs, and opercula, pale ochraceous; femora and tibiæ streaked with castaneous. Abdomen beneath castaneous, the apex pale ochraceous as above.

Tegmina and wings pale hyaline, the venation fuscous, ochraceous at basal area; tegmina with the costal membrane and upper part of basal cell ochraceous.

The face is very globose, centrally sulcated (excepting at base), and obliquely striated; the rostrum reaches the intermediate coxæ; the opercula are short, not extending beyond the basal segment, are convexly rounded, and overlap at their inner margins.

♀. Head and thorax above pale greenish ochraceous and unicolorous.

Long., excl. tegm., ♂ 34, ♀ 30 millim.; exp. tegm. ♂ ♀ 90 millim.

Hab. Australia, Swan River. Coll. Dist.

This somewhat large species of *Cicada* is allied to *C. intersecta*, Walk., and like that species has the pale apex to the abdomen; but *C. extrema* may be at once recognized by the more robust and less symmetrical body, the head and thorax being relatively wider, the unspotted head and thorax, the longer second apical area to the tegmina, &c.

Cicada madagascariensis, sp. n.

♂. Body above dull ochraceous. Head with the margins of front, fasciæ to lateral areas of vertex, and the area of the ocelli, black. Pronotum with a central longitudinal fascia margined with black (these black edges sometimes obsolete). Mesonotum with four obconical dull castaneous spots, the central pair shortest and somewhat fused, a similarly coloured spot in front of the basal cruciform elevation. Body beneath and legs pale ochraceous; central area of face and a fascia between base of face and eyes black.

Tegmina and wings pale greyish, semihyaline and talc-like, the venation ochraceous, inclining to fuscous towards apical areas; tegmina with the costal membrane ochraceous, the transverse veins at the bases of the second and third apical areas narrowly infuscated, and a submarginal series of small fuscous spots placed on the longitudinal veins to the apical areas.

The eyes are large, prominent, and subsessile; the rostrum reaches the posterior coxæ; the opercula are about the length of the posterior tibiæ, oblong, just or almost meeting at their inner basal margins, their apices convexly rounded but not extending beyond the basal abdominal segment.

Long., excl. tegm., ♂ 13-15 millim.; exp. tegm. 40 millim.

Hab. North Madagascar.

A very small species of the genus; its principal characteristics are its pale greyish semihyaline tegmina, with the darker venation and submarginal spots, the large and prominent eyes, and the well-developed opercula.

It is allied to *C. maculigena*, Sign., but differs from the description of that species by the smaller expansion of the tegmina, with the small submarginal fuscous spots to same; the markings of the pro- and mesonotum appear to be also altogether different.

*TIBICENINÆ.**Fidicina amazona*, sp. n.

♂. Body above olivaceous, inclining to ochraceous. Head with a central fascia to front and an irregular transverse fascia between the eyes (enclosing the ocelli) black. Pronotum with the anterior margin, the fissures, and a central transverse spot on the inner edge of posterior margin, black. Mesonotum with four obconical black spots, the central pair shortest; the anterior margin of the basal cruciform elevation and a small spot in front of each of its anterior angles black. Abdomen much shaded with black; the black markings are situate on the abdominal segments, narrowing to apex and again obliquely branching off from near base to lateral margins; the inner areas of the tympana and four longitudinal stripes on anal appendage—the central pair short—black. Body beneath and legs olivaceous; the central sulcation (partly) and transverse striations to face, margins of face, coxal spots, femoral shadings, apices of anterior and intermediate tibiæ and the tarsi, base, lateral margins, and apex of abdomen, black; abdomen with the anal appendage and a large spot on apical lateral margins ochraceous, and with a central series of blackish spots; opercula olivaceous, with their bases and margins black.

Tegmina and wings pale hyaline, the venation fuscous; tegmina with the costal membrane and basal cell olivaceous; bases of both tegmina and wings narrowly blackish.

The front has a distinct central sulcation; the face is profoundly sulcated and striated; the head beneath, sternum, and legs strongly pilose; the rostrum reaches the posterior coxæ and has its apex black; the opercula are small, just meeting at their inner basal angles, their posterior margins sinuated. The first and third apical areas of the tegmina are equal in length.

Long., excl. tegm., ♂ 25 millim.; exp. tegm. 87 millim.

Hab. Ega, on the Amazons.

A strikingly marked species, to be easily recognized by the black fasciated abdomen.

Fidicina bogotana, sp. n.

Body above brownish ochraceous; the eyes, lateral and posterior margins to pronotum, and the posterior margins of the abdominal segments pale ochraceous. Head with the anterior margin of front, a transverse fascia between the eyes,

the posterior margin of eyes, and a spot at anterior angles of vertex, black. Pronotum with the anterior margin and a transverse central spot on inner edge of posterior margin black. Mesonotum with two short, central, angulated black fasciæ at anterior margin, with a shorter and more obliterated spot on each side, a lineate spot on hinder portion of disk, a spot on each side of the cruciform elevation, the anterior margin of same, and a small spot in front of its anterior angles, black. Abdomen with the basal segmental margins narrowly blackish. Body beneath and legs ochraceous; the central sulcation (partly) and the transverse striations to face, margins of face, fascia between face and eyes, apices of anterior and intermediate tarsi, apex of rostrum, and the basal margins of opercula, black.

Tegmina and wings pale hyaline, the venation ochraceous or fuscous, their extreme bases narrowly ochraceous, streaked with black; tegmina with the costal membrane and upper part of basal cell ochraceous, the postcostal area fuscous.

The front has an obscure central sulcation, the face is profoundly sulcated and striated; the body beneath is slightly pilose; the rostrum reaches the posterior coxæ; the opercula are small, not quite meeting at their inner basal angles, their posterior margins sinuated.

Long., excl. tegm., ♂ 25 millim.; exp. tegm. 93 millim.

Hab. Bogota.

This species is closely allied to the preceding, *F. amazona*, although of very different coloration and markings. It differs also from *F. amazona* by the broader and less anteriorly produced head, the much less pilose body, the narrower central sulcation to the face, and by the shorter upper apical area to the tegmina, which is not equal to the third area in length.

Fidicina rubricata, sp. n.

♀. Body above brownish ochraceous. Head with the area of the ocelli and the hinder margin of the eyes broadly black. Pronotum with the anterior margin and a central transverse spot on inner edge of posterior margin black. Mesonotum with two central curved fasciate lines on anterior margin, a small spot in front of the anterior angles of the cruciform elevation, the anterior margin, and a large spot on each side of same, blackish; the posterior lateral margins blackish, narrowly edged with ochraceous. Abdomen reddish ochraceous (excluding central base), much shaded with black, and very strongly pilose, the hairs being distinctly ochraceous

on the lateral areas; anal appendage with an irregular black fascia on each side. Body beneath and legs ochraceous and thickly pilose.

Tegmina and wings pale hyaline, the venation ochraceous; tegmina with the costal membrane, postcostal area, and basal cell ochraceous, the extreme base also narrowly ochraceous; wings with the base narrowly pale ochraceous and the upper half of the abdominal area pale sanguineous.

The head is broad, with a profound central sulcation to front, the face is also profoundly sulcated and striated; the anterior angles of the cruciform elevation are very ill-defined; the rostrum only just passes the intermediate coxæ.

Long., excl. tegm., ♀ 30 millim.; exp. tegm. 100 millim.

Hab. Brazil (*sic*).

A species to be recognized by the ochraceous and sanguineous base of the wings and the obsolete nature of the anterior angles of the cruciform elevation.

Tympanoterpes colombiæ, sp. n.

♂. Body above brownish ochraceous. Head with the front black, its base and a central longitudinal fascia ochraceous; a broad irregular fascia between the eyes and enclosing the ocelli, anterior angles of vertex, and inner and posterior margins of eyes, black. Pronotum with two central longitudinal fasciæ (united posteriorly) and the fissures black, the posterior margin pale greenish or ochraceous, its inner edge and a spot near lateral angles black. Mesonotum with four large obconical spots (the central pair shortest), a large triangulated spot in front of cruciform elevation, and a transverse waved spot on each side of same, black. Abdomen with central transverse segmental fasciæ, narrowing and becoming obsolete towards apex. Body beneath and legs pale ochraceous; the opercula and the margins of the sternum greyishly tomentose; discal portion of the transverse striations to face, a large spot at inner margin of eyes, and the apex of the rostrum, black.

Tegmina and wings pale hyaline, the venation ochraceous or fuscous; tegmina with the costal membrane and upper half of basal cell greenish or ochraceous, the postcostal area fuscous; extreme bases of both tegmina and wings narrowly pale fuscous, the wings with a pale fuscous streak on basal half of abdominal area.

The costal edge of the tegmina is finely serrated, with the teeth minute and fuscous in hue; the face is globose, sulcated and striate; the rostrum just passes the posterior coxæ;

the opercula are small, slightly sinuated on their posterior and lateral margins.

Long., excl. tegm., ♂ 29, ♀ 27-29 millim.; exp. tegm., ♂ 94, ♀ 85 millim.

Hab. Colombia, Manaure (*F. Simons*); Bogota.—Venezuela.

Tympanoterpes Bergi, sp. n.

Head and thorax above thickly covered with ochraceous pile and wholly ochraceous, excepting a few lineate marks at base of head; the fissures, a central spot near the base of the pronotum, a spot at angles of the posterior margin to same, and a central spot to the cruciform elevation, black. Abdomen dark castaneous, the rudimentary tympanal coverings black. Head beneath, sternum, opercula, and legs thickly pilose and ochraceous in hue; coxal spots, apices of the femora, basal annulation to the fore and intermediate tibiæ, bases of the tarsi, and margins of the opercula paler in hue; apices of the tarsi fuscous; abdomen castaneous, anal appendage ochraceous on each lateral area.

Tegmina and wings pale hyaline, the venation ochraceous, inclining to fuscous. Tegmina with the costal membrane ochraceous, containing a black central line; base of the upper vein and the terminal vein to basal cell, basal claval margin, outer edge of terminal vein to radial area, and spots on the longitudinal veins to the second, third, and fourth ulnar areas, black; transverse veins at the bases of the first, second, third, fourth, fifth, and seventh apical areas very darkly infuscated; a series of longitudinal fuscous lines in some of the apical areas and a marginal row of very dark fuscous spots; wings with the abdominal area margined with fuscous and with its base ochraceous, containing a black line.

The transverse vein at the base of the second apical area to the tegmina is only moderately oblique; the rostrum reaches the posterior coxæ; the opercula are wide apart at their inner basal angles, but almost meet at their inner apical angles, their outer margins are moderately convex, and their lateral margins slightly sinuate.

Long., excl. tegm., ♂ 24 millim.; exp. tegm. 72 millim.

Hab. Argentine Republic (*Berg*).

A species to be recognized by the ochraceously pilose head and thorax and by the well-marked tegmina.

KANAKIA, gen. nov.

Head somewhat convexly produced in front, about equal in length to the space between the eyes, including outer margins of eyes about equal in width to base of mesonotum; eyes large, obliquely directed backwardly; ocelli about equally wide apart from eyes as from each other; a distinct broad central sulcation from between ocelli to base. Pronotum more than twice as broad as long, with the lateral margins prominently and somewhat acutely angulated, the lateral posterior angles moderately amplified. Mesonotum large, with the cruciform elevation well developed. Tympana totally exposed and uncovered. Abdomen in the male moderately inflated, beneath grooved before the lateral margins; the opercula small; anterior femora armed with four spines, the one near base and one near centre longest and very prominent, remaining two small, situate about apex, and the apical one minute. Face long and somewhat depressed. Tegmina and wings hyaline. Tegmina with eight apical areas; the interior ulnar area with its anterior margin convex, and with its base and apex subequal in breadth; ulnar veins well separated; basal cell twice as long as broad. Wings with six apical areas.

Kanakia may be placed near the Madagascar genus *Malagasia*, Dist.

Kanakia typica, sp. n.

♂. Body above ochraceous. Head with two castaneous spots at base of front; a spot at anterior angles of vertex, base and area of ocelli (excluding central sulcation), and posterior margins of eyes, black. Pronotum with the interior margins, two central oblique fasciæ which are narrowed and convexly united posteriorly, the fissures, and two angular spots, black. Mesonotum with four large obconical castaneous spots, all of which are united to a large castaneous spot in front of the basal cruciform elevation, which is also castaneous. Abdomen with a series of small central spots, a series of larger lateral spots more or less continued inwardly, and a subapical transverse fascia, black. Body beneath and legs ochraceous; anterior and intermediate tibiæ and tarsi, longitudinal fasciæ to femora, and coxal streaks castaneous. Face with a broad central fascia (containing a triangular spot at base), the posterior margins, and a linear spot near base of antennæ, very dark castaneous.

Tegmina and wings pale hyaline, the venation ochraceous. Tegmina with the transverse veins at the bases of the second and third apical areas darkly infuscated; the costal membrane ochraceous, with its outer edge fuscous, the postcostal area fuscous. Wings with the margins of the abdominal area narrowly infuscated.

♀. The body above darker in hue than in the male; the spots of the abdomen fused and fasciate-like in appearance and distinctly greyish tomentose; anal appendage with two oblique black fasciæ.

The rostrum reaches the posterior coxæ; the face is faintly sulcated on its posterior half and is somewhat obscurely transversely striate.

Long., excl. tegm., ♂ ♀ 37 millim.; exp. tegm., ♂ 100, ♀ 107 millim.

Hab. New Caledonia.

DORACHOSA, gen. nov.

Head about twice as long as the breadth between the eyes; the front somewhat broad and prominent; ocelli about as far apart from the eyes as from each other; lateral margins of the vertex somewhat convex; eyes very long, directed obliquely backwardly, their inner margins amplified and laminately produced inwardly. Pronotum rather more than twice as broad as long, the lateral margins straight and truncate, the posterior lateral angles moderately amplified. Mesonotum with the cruciform elevation well developed, with its anterior margin slightly gibbous, and its anterior angles very slender. Tympanal coverings absent, the tympana altogether exposed and uncovered. Face very broad, globose, and prominent. Anterior femora armed beneath with three large spines, one at base, one at centre, and one near apex. Rostrum with the apex rather broad and reaching the intermediate coxæ. Opercula very small and slender. Abdomen grooved beneath on each side before the lateral margins.

Tegmina and wings hyaline. Tegmina with eight apical areas, the ulnar veins well divided, the basal cell much longer than broad and wider at base than at apex; the interior ulnar area about as broad at base as at apex. Wings with six apical areas.

This genus is allied to *Tibicen*, from which it may at once be distinguished by the remarkable structure of the eyes; the structure of the front and face and the strongly spined anterior femora are also distinctive characters.

Dorachosa explicata, sp. n.

♂. Body above with the head and pronotum ochraceous, the mesonotum greenish ochraceous, and the abdomen castaneous. Head with a slender oblique black fascia between the eyes and the ocelli, a dark linear transverse fascia on anterior margin of vertex, and with some irregular castaneous marks at the region of the ocelli. Mesonotum with four subobsolete obconical dark spots, the central pair smallest. Head beneath, sternum, legs, and opercula pale ochraceous, the abdomen beneath castaneous; apices of the femoral spines and apex of the rostrum castaneous.

Tegmina and wings pale hyaline, the venation ochraceous, inclining to fuscous; tegmina with the costal membrane and postcostal area ochraceous.

The front has a short central apical sulcation; the face is very distinctly centrally sulcated and obscurely transversely striate; the opercula are slender, transverse, and attenuated at the apices, which are well separated from each other.

Long., excl. tegm., ♂ 12 millim.; exp. tegm. 37 millim.

Hab. Panama, Matachin.

Tibicen ega, sp. n.

♂. Body above dull dark ochraceous. Head with the lateral margins of the vertex and the inner margins of the eyes darker in hue. Pronotum with the margins dark fuscous, a central transverse fuscous spot on anterior and posterior margins, and with two faint central, linear, sinuated, fuscous fasciæ. Mesonotum with four faint darker obconical spots, the central pair shortest, a lateral fascia and a spot in front of the cruciform elevation of the same colour. Abdomen with the basal area somewhat darker in hue. Body beneath and legs dull dark ochraceous.

Tegmina and wings pale hyaline, the venation ochraceous, inclining to fuscous; tegmina with the costal membrane ochraceous, the postcostal area fuscous; the transverse vein at the base of the second apical area and the apical margin of the first apical area infuscated.

The face is very strongly transversely striate and the central sulcation is very narrow. The opercula are very small, with their basal margins somewhat darker in hue.

Long., excl. tegm., ♂ 14 millim.; exp. tegm. 42 millim.

Hab. Ega, on the Amazons.

A small and obscurely marked species, in coloration allied to *T. guatemalanus*, Dist.

Tibicen pumilus, sp. n.

♂. Body above dull dark ochraceous. Head with the interior margins of eyes, lateral margins of vertex, and the area of the ocelli black. Pronotum with a pale ochraceous central fascia, the fissures and a spot on each side of disk black. Mesonotum with four obconical black spots, the central pair shortest, and a black spot in front of the anterior angles of the basal cruciform elevation. Abdomen greyish tomentose, the basal segmental margins blackish, the apical segmental margins pale ochraceous, excepting the two basal segments, which are almost uniformly greyish tomentose; the lateral margins of the last four segments are also distinctly blackish, and the base of the anal appendage is of the same colour. Head beneath black, the margins of the face ochraceous. Sternum, legs, opercula, and abdomen beneath ochraceous; sternal spots, coxal streaks, longitudinal fasciæ to anterior femora, the intermediate and posterior femora (excluding bases and apices), apices of anterior and intermediate tibiæ and tarsi, the rostrum, the margins of the sonorous orifices, and the apical segment of the abdomen, dark castaneous or blackish.

Tegmina and wings pale hyaline, the venation fuscous; tegmina with the costal membrane ochraceous, its base fuscous.

The rostrum just passes the intermediate coxæ; the opercula are small and convexly rounded.

Long., excl. tegm., ♂ 9–10 millim.; exp. tegm. 27–30 millim.

Hab. New Caledonia.

A small species of the genus, in size somewhat allied to the Australian *T. Gregoryi*, Dist., and to be recognized by its very distinctive coloration and markings.

Tettigades parva, sp. n.

♀. Body above black; the eyes, the anterior and posterior margins of the pronotum, lateral and posterior margins of the mesonotum, anterior angles of the cruciform elevation, and posterior margins of the last two abdominal segments and of the anal appendage, ochraceous. Body beneath black and pilose; lateral margins of the face, sternal spots, coxal streaks and apices, bases and apices of the femora, posterior tibiæ and tarsi (*intermediate tibiæ mutilated*), disk of the abdomen, and lateral margins of the anal appendage, ochraceous.

Tegmina and wings pale hyaline and talc-like. Tegmina
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with the venation fuscous; the extreme base, the costal membrane (excluding inner margin), the basal cell, the basal and apical veins of the lower ulnar area, the transverse veins at the bases of the three upper ulnar areas, and a spot on the lower vein of the third ulnar area, ochraceous. Wings with the venation of the basal area ochraceous, remainder fuscous.

The rostrum reaches the intermediate coxæ; the face is distinctly sulcate, but obscurely striate.

Long., excl. tegm., ♀ 14 millim.; exp. tegm. 45 millim.

Hab. Argentine Republic (*Berg*).

A small species allied to *T. chilensis*, A. & S., from which it differs by its smaller size, the black lateral margins to the pronotum, the black centre of the cruciform elevation, the much less pilose surface of the body beneath, the less broadly sulcated face, &c.

Melampsalta luberculata, sp. n.

♀. Head and thorax above ochraceous; head with the margins of front, a lineate spot near anterior angles of vertex, and a very broad fascia between the eyes, enclosing the ocelli, black. Pronotum with two central fasciæ rounded and joined posteriorly, a spot on each side, and the fissures, black; a black spot on posterior margin at the lateral angles. Mesonotum with four large obconical spots (the central pair shortest), a central lanceolate fascia, anterior margin of cruciform elevation, a spot on its anterior angles, and a small spot in front of the same, and the posterior lateral margins, black. Abdomen black, moderately pilose, the posterior segmental margins very narrowly ochraceous; a spot on each side of the last dorsal segment, two large lateral spots (basal and apical), and two central lines to anal appendage, ochraceous. Body beneath and legs ochraceous; a broad central fascia to face on each side of the sulcation, base and apex of rostrum, sternal spots, longitudinal streaks to femora, anterior tibiæ (excluding bases), bases and apices of intermediate tibiæ, apices of the tarsi, a broad central fascia to abdomen, and anal appendage (the last centrally united with the dark coloration above), black.

Tegmina and wings pale hyaline: tegmina with the venation fuscous, the costal membrane ochraceous, and with a large blackish spot on the transverse veins at the bases of the second and third apical areas; wings with the venation ochraceous and fuscous.

Long., excl. tegm., ♀ 20 millim.; exp. tegm. 62 millim.

Hab. Australia (no precise locality).

This species cannot well be confused with any other of the Australian *Melampsalta*. By the prominent subapical spotting of the tegmina it is somewhat allied to *M. umbrimargo*, Walk., and *M. convergens*, Walk., but with both these species it has nothing else in common.

SYNONYMICAL NOTES.

Tympanoterpes sodalis.

Cicada sodalis, Walk. List Hom. i. p. 108. n. 9 (1850), = *Fidicina vultur*, Walk. Ins. Saund. Hom. p. 10 (1858).

Melampsalta mangu, B. White, Ent. Month. Mag. vol. xv. p. 214. n. 63 (1879), = *Melampsalta nervosa*, Walk. List Hom. i. p. 213. n. 166 (1850).

Tibicina lacteipennis, Puton, Rev. d'Ent. ii. p. 45 (1883).
N. Persia.

This name is already preoccupied in the genus *Tibicen* by *T. (Cephaloxys) lacteipennis*, Walk. List Hom. i. p. 237. n. 8 (1850), described from North India. I therefore propose to rename the Persian species as *T. Putoni*.

VIII.—The *Apodemes* of *Apus* and the *Endophragmal System* of *Astacus*. By HENRY M. BERNARD, M.A. Cantab.

[Plate V.]

THE endophragmal system of *Astacus* has been a considerable puzzle to all who have studied the subject. Though the elements of which it is made up are clearly seen to be folds of the outer skin, in some way connected with segmental constrictions, it has never been understood how they arose. No muscles are apparent which could have drawn them in; indeed, some of those attached to them, *e.g.* the coxal muscles, pull in the opposite direction, *i.e.* tend to straighten the skin and not to draw it into folds.

When attempting lately to show * that *Apus* is a primitive Crustacean nearly related to the Annelids, I was many times struck with the close resemblance between it and the Macrurous Decapod Crustaceans, and could not refrain from

* "The Apudidæ." Macmillan, 1892.

hoping that some one would attempt a detailed deduction of *Astacus* from the Apodidæ. As a contribution to such an attempt, I propose here to show how *Apus* supplies us with a full explanation of the endophragmal system of *Astacus*.

Apodemes, or inward foldings of the skin, are very plentiful in *Apus*, and their origin is in all cases clear.

We have, first of all, the segmental constrictions, which are naturally obliterated in the stretched regions of the body, but very marked in longitudinally compressed regions. For our present purpose we confine our attention to the constrictions on the ventral surface anteriorly. In some specimens, according to the state of contraction at death, these are very deep and throw the ventral cord into a series of waves (cf. Pl. V. fig. 7).

In *Astacus* the moving forward of the anterior trunk-limbs to function as mouth-parts or maxillipedes, and the consequent longitudinal compression of this region of the body, necessarily caused these constrictions to form high fixed barriers across the inner ventral surface. Over these barriers the ventral cord had at first either to stretch, or to form a series of arches. Each barrier has, however, in time been cut down in the middle line, so that the cord has come to lie in a groove along the ventral surface, known as the sternal canal. The subsequent arching over of the canal by sinewy matter is a secondary arrangement which also receives its explanation in *Apus*, as we shall presently see.

So far, this explanation of the origin of the endosternites (as the two halves of these constrictions are called) is simple enough. The origin of the endopleurites (or endotergites as they are sometimes called) is not quite so evident.

Taking first the endopleurites between the trunk-limbs, we find that in *Apus*, in the anterior part of the body, where the limbs are developed, the two ventral longitudinal muscle-bands are attached to the segmental folds between the limbs. These points of attachment naturally tend to be drawn inwards by the action of these muscle-bands. Further, as the pulls of the muscles are in the longitudinal direction, the folds naturally acquire the diamond-shape shown in the tangential sections (figs. 5, 6). In these apodemes the dorso-ventral diagonal is the natural direction of the segmental constriction; the longitudinal diagonal is due to the pulls of the muscle-bands. By comparing the sections we find that each of these apodemes in *Apus* is pulled backwards as far as the segmental constriction posterior to that to which it really belongs. This is easy to understand; the length of the posterior region in *Apus* and the use made of it for sudden

diving movements make it probable that the prevailing pulls of these muscle-bands are for the bending of the abdominal region. But although the greater part of the apodeme thus slopes backwards, there are indications of a slight anterior pull in its diamond form.

Turning now to *Astacus*, we find very pronounced apodemes dorsally to the limbs, and in the line between them. These are clearly homologous with the apodemes of *Apus*, and originate as part of the segmental constriction between the limbs. How they came to be drawn in we have learnt from *Apus*; they were originally the points of attachment of the segmental constrictions to the ventral longitudinal muscle-bands inherited from the original Chætopod Annelid, and retained in *Apus*. This origin is no longer apparent in *Astacus*. Internally these endopleurites give off two branches, one running posteriorly to the endosternite belonging to the next posterior constriction, and one running in towards its own endosternite. The former alone of these is, as above described, developed in *Apus*, and has been handed on to *Astacus*; but whence came the anterior branch?

A trace of this anterior branch is, as we have seen, present in *Apus*, and might be easily developed if it were to be submitted to any strong anterior pulls of the longitudinal muscle-bands. This is clearly what has happened in *Astacus*, and we have abundant evidence of such persistent anterior pulls in the compression of the anterior ventral region. The effort to bring forward the four anterior pairs of legs as maxillipedes and forceps must have meant, for many generations, a strong contraction of the ventral longitudinal muscles connecting the somites to which these limbs belong. To this, then, I attribute the development of the anterior branch of the endopleurite.

The parallel between *Apus* and *Astacus* is, however, by no means complete. The most anterior of the folds forming the endophragmal system of *Astacus* cannot be called either an endopleurite or an endosternite, because it is one deep continuous furrow only interrupted by the sternal canal. It occurs between the 2nd maxillæ posteriorly and the paragnatha and mandibles anteriorly. So capacious is it that the 1st maxillæ may be said almost to spring from the bottom of it. It is, in fact, nothing more than the sinking in of the region of insertion of these limbs.

Apus again supplies us with a complete explanation of this phenomenon. The Sections 1-7 show us a very deep fold behind the underlip, which runs in above the insertion of the 1st maxilla. It is so pronounced that it forms one of

the principal supports of the "sternal plate"*. It runs in further than any of the other lateral apodemes of *Apus*. I consider the fold of some importance, and due not so much to the bending round of the five annelidan segments to form the crustacean head†, as to the forcing back of the underlip in order to bring the mandibles in front of it. The counterpart of this fold may be seen in a small apodeme in front of the mandible, due to the forcing forward of the latter in front of the underlip (fig. 2 a).

This very pronounced fold behind the underlip in *Apus* very nearly coalesces with another less pronounced apodeme between the 1st and 2nd maxillæ. The fold between these limbs is very deep, as is also that between the 1st trunk-limb and the 2nd maxilla (Section 1). I am inclined to attribute these to the bending round of the segments to form the head.

It is clear, therefore, that we have in *Apus*, just behind the underlip around the insertion of the 1st maxilla, an area of subsidence, which, if it sank, would infallibly draw this limb down with it, so that it would then spring from the base of the fold.

In *Astacus* this subsidence has actually taken place, and the cause of it is not far to seek. The bringing forward of the anterior trunk-limbs as maxillipedes necessarily compressed the region of the body between these limbs and the mouth, with the natural result that any tendency of the skin to form folds in this region would at once be taken advantage of, and the fold would become deeper. That this is the true account of the origin of this fold in *Astacus* can still be made out from an examination of its structure. It shows its composition out of two apodemes, the anterior of which, as in *Apus*, is much the more pronounced, bending forward at its proximal end into a strong horn-like prolongation, which is clearly the homologue of the stout apodeme marked *b* in the sections. If this is the case, then the sinewy tissue joining the folds of the two sides across the middle line and thus bridging over the sternal canal is the rudiment of a sternal plate like that of *Apus* and *Limulus*.

Following on this first fold of the endophragmal system of *Astacus* is a somewhat complicated arrangement of folds and ridges. The chief complication seems to be due to the fact that the endopleurite between the first and second trunk-legs (or

* This is commonly called the endosternite, but, having already (following Huxley) used that term for the ventral apodemes, I here use an alternative term for the sinewy mass to which the ventral longitudinal bands are attached anteriorly.

†. Vide 'The Apodidae,' pp. 10 *et seq.*

maxillipedes) has been drawn forward dorsally to, and a little in front of, that between the 1st maxillipede and the 2nd maxilla. We can only explain this by supposing that the muscle-pull on the first endopleurite was very small, while it was very strong on the second and following endopleurites. This explanation is borne out by the fact that, in *Astacus*, no anterior branch of the first endopleurite is developed. This is easy to understand if we refer to Section 5. In this we see the change that has to take place to give us the transposition of the 1st and 2nd endopleurites in the endophragmal system of *Astacus*. In order to bring up the trunk-limbs to act as maxillipedes, the muscular contraction must act on the apodemes behind them, not in front of them. Hence we find that, while the endopleurite marked *d* has nearly retained its original position, the endopleurites *f, g, h*, &c. have been drawn into positions *f', g', h'*, &c. indicated on the Section (5) by dotted lines. The endosternites have been also affected, those corresponding to *d* and *f* having been drawn very close together.

In addition to the longitudinal compression repeatedly referred to above, the anterior part of the thorax of *Astacus* has been subjected to considerable lateral compression, also due to the transformation of trunk-legs into mouth-parts. This has naturally forced the transverse segmental constrictions into folds, which are still visible in the buttress-like backward prolongations of the endosternites, and perhaps also in the sternal canal. This lateral compression of the thorax in *Astacus*, forming a keel along the sternum, very marked in the lobster, is in interesting contrast to what has taken place in *Branchipus*, where the sternum is bent in exactly the opposite manner, *i. e.* upwards, leading to a separation of the two longitudinal halves of the ventral cord.

Tempting as it is, it is hardly necessary to show how the posterior portions of the endophragmal system of *Astacus* may be accounted for. They afford abundant evidence of the strong muscular contractions which originally compressed the thoracic somites.

I have thus, I think, made it very clear that *Apus*, with its powerful ventral longitudinal muscle-bands and its flexible skin, supplies us with a complete explanation of the endophragmal system of *Astacus*, in which the ventral muscle-bands, except those specialized for moving the tail, have almost entirely disappeared, and in which the deep folds of the skin which the now vanished ventral muscles once called into existence have become permanent calcified ridges, fastened together by sinewy connective tissue.

We have now, lastly, to explain the changes which have taken place in the ventral longitudinal bands of *Apus* and their attachments, to form the flexor muscles of *Astacus* with their somewhat different attachments.

In *Apus* the muscle-bands are attached solely to the endopleurites. Anteriorly they are attached to the large apodeme behind the underlip, and run backward in a band until they gradually widen out to form, in the limbless segments, a dermo-muscular tube.

In *Astacus* a great change has taken place. As above described, the anterior part of the thorax has undergone lateral as well as longitudinal compression, due to the transformation of legs into maxillipedes. The *lateral* compression caused the longitudinal bands of the two sides to meet in the middle line, with a consequent fusing of the sinewy segmental partitions of the one band with those of the other. The *longitudinal* compression caused the ventral segmental constrictions to become the fixed permanent endosternites, which were pressed up till their inner edges fused with these same sinewy partitions.

When it was no longer necessary further to compress the thorax, in order to turn the anterior trunk-limbs into maxillipedes, the greater part of the muscles degenerated, leaving, however, the branches of the endopleurites bound to the endosternites by the sinewy tissue which persisted after the muscle elements disappeared. The most important parts of the ventral longitudinal bands which were retained were those which ran either downward into the limbs or backward into the abdomen. Of the former, we find the coxal muscles in *Astacus* attached to the sinewy capitals of the pillar-like endosternites. We have, in fact, muscles pulling outwards attached to each side of a fold of the skin! It is evident that this must have been a secondary arrangement, as no fold of the skin could possibly have arisen under these circumstances. There is, however, no difficulty if we refer to *Apus*. There we find these coxal muscles springing from the sinewy partitions in the ventral muscle-bands. By the longitudinal compression of the thorax already mentioned, the segmental constrictions in *Astacus* were forced up until their inner edges fused with these sinewy partitions. Hence the coxal muscles naturally come to descend from the upper edges of the segmental constrictions or capitals of the endosternites.

The abdominal muscles require little notice. The order of their attachments to the endosternites of the thorax is just what we should have expected from their origin. As we go

backward we find the continually thickening flexor muscle of the abdomen with which we are all familiar.

Owing to the comparatively undifferentiated character of the long muscle-bands of *Apus*, treated as a primitive crustacean, it is probable that no part of the band contracted without leading to a partial contraction of the rest. We accordingly find the ventral curve of the body much more pronounced in the *Brachyura* than in the *Macrura*. In the former, while there seems to have been no lateral compression, the longitudinal compression of the thorax has been much greater than in the latter, and the maxillipedes are far more pronounced as mouth-parts than they are in *Astacus*.

There are other points in the anatomy of *Astacus* which can be shown to have been modified from a more primitive condition, such as we find in *Apus*. But we must pass over these for the present and conclude with a few descriptive notes on the sections of *Apus glacialis* given in the drawings.

EXPLANATION OF PLATE V.

Description of Sections.

These are all from camera lucida outlines. The detail of the inner organization is somewhat simplified, *e. g.*, the sections through the branchings of the liver and the genital glands are omitted in 6.

Fig. 1. Sagittal section through the right side of a specimen of *Apus glacialis*, Kröyer.

ag, the salivary gland, attached to the body-wall by muscle-bands, like a typical acicular gland. This may be followed through the sections till it opens in a transverse groove shown in Section 7.

sg, the shell-gland, which is here seen running out laterally towards the dorsal parapodium of the 2nd maxilla (*m''*).

L, labrum, or large upper lip.

m, mandible.

l, metastoma or underlip, which is here seen projecting laterally.

m', *m''*, 1st and 2nd maxillæ.

1, 2, 3, first three trunk-limbs which, in *Astacus*, were forced forward towards the mouth as maxillipedes.

4, the 4th limb which, in *Astacus*, becomes the forceps.

Fig. 2. The same, six sections further on.

a, the apodeme in front of the mandible, probably due to the forcing of the latter forward.

sp, the sternal plate, which first comes in view as a *strongly curved mass*. This is of interest in connexion with my attempted deduction of *Apus* from an Annelid with the first five segments bent round to form the new head. The curve is very pronounced in Sections 2, 3, 4, and partly in 5. In Sections 6 and 7, which lie nearer the middle line, we have only the posterior portions of the sternal plate, which naturally lie straight.

b is the large fold behind the underlip, due, I think, to the forcing of the lip backward.

c is the apodeme behind the 1st maxilla; *b* and *c* together form the area of subsidence described in the text which gives rise to the great fold commencing the endophragmal system of *Astacus* anteriorly.

Fig. 3. The same, four sections further in towards the median plane.

Fig. 4. The same, three sections further in than 3.

d and *f*, apodemes between *m''* and the 1st trunk-limb, and between the 1st and 2nd trunk-limbs. In *Astacus* *f* has been drawn to the position marked *f'*, as shown in:—

Fig. 5. The same, five sections further in than 4.

Fig. 6. Seven sections further in than 5. The gnathobases are seen as distinct appendages; the anterior trunk apodemes are no longer visible, only the large one, behind the underlip, which forms the support of the sternal plate and the anterior attachment for the longitudinal musculature, remains. In the specimen these muscles had been torn from the apodeme, as shown in the drawings. The apodemes which are still visible in the posterior segments are clearly seen to have travelled backward so as to come nearly over the segmental constrictions posterior to those to which they properly belong. This gives us the posterior branch of the endopleurite of *Astacus* (*cf.* text).

e, eggs in the genital tube.

Fig. 7. A nearly median section.

n, the ventral cord thrown into slight waves by the ventral constrictions.

m, teeth of the mandibles.

æ, the œsophagus.

mg, the wall of midgut.

sp, the median portion of the sternal plate which binds the two apodemes behind the underlip across the middle line. The underlip is represented by the ridge *l*. It is to be noticed that no muscles run into the underlip excepting here, close to the median plane. These bands may have originally formed the true anterior ends of the ventral longitudinal muscles.

IX.—On a new Genus of *Oligochæta*, comprising Five new Species, belonging to the Family Ocnerodrilidæ. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Zoological Society of London.

[Plates VI. & VII.]

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I. INTRODUCTORY.

THE material upon which the present paper is based consisted of a large number of living worms, all of which I received, through the kindness of the Director of the Royal

Gardens, from Kew ; these specimens were all carefully preserved for purposes of section-cutting, the only method of studying small worms which are not large enough for dissecting, and which are too opaque to admit of examination while alive. I have invariably made longitudinal sections of the anterior twenty segments or so, which I believe to be much more satisfactory than transverse sections. This method is equally good for the purpose of studying the histology of the organs, and is of course far better than the method of transverse sections for fixing with precision the position of the various organs—so important a point in Annelid anatomy.

There are not many groups of animals now in which it is possible to find in a few months, and as it were accidentally, four new species, constituting a well-marked new genus. The fact that during the year 1890 forty-eight new species and twelve new genera were described by only eight naturalists with no special facilities (except in the case of one) for collecting, shows that much remains to be done before this group of Annelids is anything like exhausted. And, moreover, most of these new species do not differ merely by some trifling external character, of no interest except to the systematist, but show for the most part important anatomical differences often of more than merely classificatory interest.

The five new species, of which I give an account here, were all found in the earth in which tropical plants had been imported to the Kew Botanical Gardens. Seeing that this accidental transference of worms from one country to another is so easy, it behoves one to be very careful in drawing conclusions as to the geographical distribution of the group.

I place this new genus near to *Ocnerodrilus*, and, on account of certain peculiarities in the first species, name it *Gordiodrilus*.

II. DESCRIPTION OF FIVE NEW SPECIES OF *GORDIODRILUS*.

In the following account I have endeavoured to avoid any unnecessary repetition ; where any organ presents exactly the same structure in all species, I have only described it once in detail.

1. *Gordiodrilus tenuis*, sp. n. (Pl. VII. fig. 6 C.)

The material consisted of one specimen only from Assaba, on the west coast of Africa.

The worm was during life extraordinarily thin and active in its movements ; its general appearance was suggestive rather of a Lumbriculid or a *Phreoryctes*, particularly of the latter genus.

The resemblance to *Phreoryctes* naturally implies a likeness to the Nematoid *Gordius*. This resemblance, which was not lost after preservation with Perenyi's solution, followed by alcohol, is due to the very great length of the worm as compared with its breadth. *Gordiodrilus tenuis* can perform a feat which needs a considerable length of body: the specimen under consideration had actually tied its body into a knot; this suggested the generic name.

A special point of resemblance to *Phreoryctes* is the great length of the segments as compared with their breadth; the length is equal to, or even exceeds, the diameter; and this statement, it should be observed, applies not only to the living worm, but also to the worm after preservation with reagents that cause a considerable amount of contraction.

Another remarkable characteristic of this annelid was first appreciated when it was lifted out of the basin of water in which it had been placed to thoroughly free it from soil. Under these circumstances the setæ were very distinctly felt for so slender a worm; it clung to the fingers, and was only with some little difficulty to be detached. This is due, as I shall point out later, to the large size of the ventral setæ. The colour during life was of a creamy white diversified with red marks (the larger blood-vessels); there appeared to be no pigment in the skin; the white colour is due to the coelomic corpuscles, which are exceedingly numerous. In examining a collection of Oligochæta from tropical Africa, one is inclined to assume that they will prove to belong to the family Eudrilidæ, which is so characteristically an African family; and as a matter of fact, all the other specimens which I received from Assaba along with this *Gordiodrilus* do belong to that family. After the first superficial examination of the Annelid at present under consideration I was disposed to refer it to the genus *Megachæta*, lately described by Michaelsen in one of the most interesting of his many contributions to the structure and distribution of the Oligochæta*. Of *Megachæta tenuis*, one of the two species of the genus, Michaelsen remarks that it is "der schlankeste Teleudriline, der mir zu Gesicht gekommen ist. Das vorhandene aus 162 Segmenten bestehende Stück ist 120 mm. lang bei einer grösste Dicke von nur 1 mm." (p. 17). It shows, furthermore, a great disparity in size between the ventral and dorsal setæ; in fact, anyone judging from external characters only would undoubtedly refer my *Gordiodrilus tenuis* to Michaelsen's genus *Megachæta*. This is, however, only another

* "Beschreibung der von Herrn Stuhlmann auf Sansibar und dem gegenüberliegenden," &c., SB. Hamb. Wiss. Aust. Bd. ix.

instance of how impossible it is, in this group of animals, to determine affinities by the outside only; alike as they are superficially, it is not much, if any, exaggeration to say that few genera are structurally farther apart than *Gordiodrilus* and *Megachæta*. If there were any scope for the action of natural selection in this direction, some might regard this resemblance as an instance of the phenomenon known as "mimicry." It is, however, difficult to see in what way one kind of worm would be advantaged in resembling another, as the characters are not so striking as to appeal to the eyesight of the natural friends or foes of either.

The length of *Gordiodrilus tenuis* after preservation was about 90 millim., the breadth 1 millim.; the body was bent into a spiral, which I have never noticed except in the long and thin aquatic worms.

External Characters.

An examination of a portion of the body-wall mounted in glycerine shows the reason for the curious way in which the worm clings to the finger when handled. Some of the *setæ* are very large; if the body-wall be examined with a lens only, there appear to be only two pairs to each segment. A more careful examination, however, shows that the normal four pairs are present in each segment of the body, with the exception, of course, of the first; the lateral pairs are so small as to escape observation, owing to the eye being accustomed to the large ventral *setæ*, unless a moderately high magnifying-power is used. The *setæ* are strictly paired, and the lateral *setæ* are about a quarter of the bulk of the ventral *setæ*; the latter are, however, not absolutely of the same size; the innermost seta of each pair is rather larger than the outermost. There is nothing unusual in the shape of these *setæ*; they have the sigmoid form so generally met with among the *Oligochæta*, but the tip is perhaps slightly more hooked than is ordinarily the case; this is no doubt partially a cause of the tenacious way in which the worm clings to the finger. Among worms which have sigmoid *setæ* in both dorsal and ventral bundles (*Phreoryctes*, *Lumbriculidæ*, nearly all "earthworms"), it is by no means common to find such a great difference in size as that which has been recorded in *Gordiodrilus tenuis*. There are, however, several forms where a like difference does occur. In *Phreoryctes*, for instance, which has besides a certain superficial similarity to *Gordiodrilus*, there is commonly a similar inequality in size between the dorsal and ventral *setæ*. In

P. Smithii the dorsal are the larger, but in *P. Heydeni* Noll* figures the ventral setæ† as being slightly the larger, and in *P. emissarius*‡ the dorsal setæ diminish in size posteriorly and finally disappear. In *Megachæta* there is a still closer resemblance to *Gordiodrilus tenuis*, for the two ventral setæ are not only larger than the dorsal, but the individual setæ of each ventral pair are unequal in size, the innermost of the two being distinctly the larger. But there is also a regular and progressive increase in size, affecting not only the ventral, but also the lateral setæ. Even in *Perichæta*, with the circle of numerous setæ in each segment, the ventralmost ones are in a few cases (e. g. in *P. Houletti*) decidedly larger than the rest. These cases are interesting as showing the differentiation of a dorsal and ventral surface, which, so far as the setæ are concerned, is not always apparent in the *Oligochæta*. It would add to the interest if it could be ascertained whether there is any corresponding modification of habit; whether, for example, *Megachæta* and *Gordiodrilus* frequent the surface of the soil rather than its depths.

The *clitellum* was not apparent until the worm was examined by means of sections. It is very extensive, reaching from the xivth to about the xxviiith segment, and is only developed dorsally.

I could not find any dorsal pores.

The *nephridiopores* open in front of the lateral setæ.

Internal Structure.

Having only one specimen of this *Oligochæte* for examination, I am not able to give so complete an account of *Gordiodrilus tenuis* as I could wish, and as I have been able to give concerning the other species of the genus. My account is, moreover, rendered less complete than it would otherwise have been by the fact that the sections were in many places insufficiently stained. Nevertheless I have been able to make out the principal facts which bear upon the systematic position of the Annelid. The thickness of the cuticle was very remarkable; it appeared to me to be proportionately thicker than in any earthworm which I have

* "Ueber einen neuen Ringelwurm des Rheins," Arch. f. Naturg. Jahrg. 40, p. 260.

† There is a little confusion about this matter. Claparède's *Nemodilus fliformis*, which Vejdovsky believes to be identical with Noll's *P. Heydeni*, is stated to have longer dorsal setæ by both Claparède and Vejdovsky, though Claparède's figures show the reverse.

‡ Fortes, "On an American Earthworm of the Family Phreoryctidæ," Bull. Illin. Lab. vol. iii. p. 107.

examined. The coelom was crowded with corpuscles, which appeared, however, to be chiefly compacted together to form an investment for the nephridia.

The presence or the absence of an abundant coating of glandular peritoneal cells upon the nephridia no longer distinguishes "earthworms" from "waterworms." Although the majority of the latter have the nephridia covered with large clear vesicular cells ("globules incolores" Claparède calls them), they are occasionally replaced by a thin layer of flattened peritoneal cells. On the other hand, in *Phreoryctes* the "glandular" investment of the nephridia attains very great dimensions. In earthworms the rule is perhaps for the nephridia to be coated with only a thin layer of peritoneum. Perrier was the first* to draw attention to the fact that in this group also there is no uniformity; for in *Pontodrilus* an investment of the nephridia occurs which is fully as thick as that which covers the nephridia of *Phreoryctes*. The Eudrilidæ nearly all show this structural peculiarity; for example, *Libyodrilus*† and *Megachæta*‡. In *Ocnodrilus*, which I regard as the nearest ally of *Gordiodrilus*, the nephridia have been described by me § as partly imbedded in a huge mass of clear cells. These cells are often (e. g. in *Heliodrilus*, *Hyperiodrilus*, and *Libyodrilus*) loaded with spherical bodies, which are probably to be regarded as excretory products. But in that case the accumulation of such cells round the nephridia—themselves excretory organs, seems to be superfluous. Kükenthal ||, however, is of opinion that these "lymphoid cells" are related rather to the blood-vessels than to the organs (e. g. the nephridia) which they and the blood-vessels cover. So far as concerns the nephridia in the Eudrilidæ, there is no objection to this view. But in *Ocnodrilus* the nephridia have no blood-vessels, and yet an abundant covering of the cells in question occurs. Kükenthal believes that these cells extract waste products from the blood, and finally breaking down in the coelom set free their accumulated stores of excreted matter which reach the exterior *viâ* the nephridia; this, of course, only applies to the lymph-cells with brown granular contents which clothe the

* "Études sur l'organisation des *Lombriciens* terrestres: IV. Organisation des *Pontodrilus* (E. P.)," Arch. d. Zool. Exp. t. ix. p. 205.

† Beddard, "On the Structure of an Earthworm allied to *Nemertodrilus*," &c., Quart. Journ. Micr. Sci. vol. xxxii. p. 3554.

‡ Michaelsen, *loc. cit.*

§ "On the Anatomy of *Ocnodrilus* (Eisen)," Trans. Roy. Soc. Edinb. vol. xxxvi. pt. ii. p. 563.

|| "Ueber die lymphoiden Zellen der Anneliden," Jen. Zeitschr. Bd. xviii. p. 319.

dorsal vessel and its branches; the relationship of the peritoneal cells to the other blood-vessels is supposed to be rather to the advantage of the cells than of the blood; the cells grow and multiply, and then break off to perform their useful function in life elsewhere. This, however, does not explain the association of the cells with the nephridia in *Gordiodrilus tenuis* and in other species. So far as the facts enable a generalization, it seems that heat or damp or both combined are related to the abundance of these cells upon the nephridia. Excretion may be more rapid under these circumstances. When the excretory epithelium—the “drain-pipe” cells—is in action, the products of their activity must be thrown off in every direction, not only into the lumen of the tube. It may be therefore that the peritoneal cells serve as store-houses of this waste matter, which is kept close at hand ready for excretion, instead of being thrown off into the body-cavity and having to be laboriously re-collected. The coelom, as in all Oligochæta with the exception of *Æolosoma*, is divided by septa into chambers corresponding with the external metamerism. Some of the anterior septa, as is also usually the case, are of much greater thickness than the others. This applies to the septa separating segments v.-xii.

With regard to the *alimentary canal*, there seems in the first place to be no gizzard. The *single ventral calciferous gland* (the minute structure of which will be described under *Gordiodrilus elegans*) is present. The intestine has no typhlosole.

The *reproductive organs* I am fortunately able to describe more completely; there appears to be only a single pair of *testes*, which occupy the usual position in segment xi. (*i. e.* attached to the front wall of that segment). Owing to the fact that the intersegmental septa are very much broader than the diameter of the body, the successive septa in the anterior region of the body, as is so frequently the case with the Oligochæta, are placed within each other like a series of cups, the concavity being forward. Owing to this disposition of the septa, which seems to be exaggerated in *Gordiodrilus tenuis*, the testis of each side is pressed between the septum and the parietes. The septum separating segments x./xi. runs for a considerable distance nearly parallel to the parietes; in the narrow space left between the two the testis is wedged.

The *sperm-sacs* occupy segments x.-xiii. about; but I have not been able to make out their arrangement very clearly; like most of the organs lying in the centre of the body, they were but slightly stained.

The *vas deferens* like the testis is single on each side of

the body; each vas deferens commences with a very large funnel which reaches from top to bottom of the cavity of segment xi.; the tube arising from this passes back closely adherent to the ventral parietes and opens on to the exterior in the xith segment, not far behind the septum which separates that segment from the one in front. The external orifice is therefore in front of the setæ of the segment, and to the outside of the ventral couples.

There is nothing that calls for special remark in the minute structure of the vasa deferentia; they are formed of the usual cubical cells, which are ciliated. At the external aperture there is no glandular body connected with the vas deferens, nor are there any modified setæ of any kind. The great length of the vasa deferentia is rather unusual; it is not often that these tubes occupy so many as ten segments, though occasionally they may be even longer than in the present species. Although the vasa deferentia are entirely unconnected at their external orifice with any glandular bodies, a pair of tubular glands open on to the exterior on each side in the immediate neighbourhood of the male pores.

The tubular form of these glands, and the fact that there is a pair of them on each side of the body—one in front of and one behind the male pores—recalls the very characteristic arrangement met with in the family *Acanthodrilidæ*, and hitherto only found in that family*. But although there is this general similarity, there is also an important difference, namely that the *atria*, as I may term them, *open on to two consecutive segments in Gordiodrilus tenuis*. These segments are xx. and xxi.

In the *Acanthodrilidæ* the *atria* are, as I myself was the first to point out, quite independent of the vasa deferentia; but they open nearly invariably† on to the xviith and xixth segments.

The *atria* extend through several segments; they are, as in *Acanthodrilus*, bent upon themselves once or twice. The minute structure of the *atria* is also of interest. As in *Acanthodrilus* and in other genera in which there are tubular *atria*, the glands consist of a glandular and a muscular part. The muscular part of the atrium is rather short. *The*

* Bourne's *Perichaeta Stuarti*, which appears to show something of the same kind, requires re-investigation.

† Perrier (Nouv. Arch. d. Mus. t. viii.) has described the atrial pores of both *Acanthodrilus obtusus* and *A. verticillatus* as being upon two consecutive segments; the xixth and xxth in one case the xviith and xviith in the other.

glandular part is lined by a single row of glandular cells, which are less stained than the surrounding tissues and are filled with excreted granules. In the Acanthodrilidæ, and, in fact, in all other earthworms with tubular atria, the epithelial lining is divisible into two distinct layers, with cells of a different character in each. The Moniligastridæ are partially at least an exception to this rule; and so too is Ocnerodrilus, one of those forms which stand on the borderline between the "Terricolæ" and the "Limicolæ" of Claparède. The structure of the atria of the last-mentioned genus appears in fact to be exactly similar to that of Gordiodrilus. The reduction of the two layers of epithelium to one may perhaps be regarded as a degeneration, correlated possibly with the small size of the worms; but against this hypothesis is the fact that species quite as small as these have atria with the normal two layers of cells.

The ovaries occupy the usual position in segment xiii.; like the testes they are pressed close against the parietes of the body by the septum separating segments xii./xiii. The oviducts open into the xiiiith segment opposite to the ovaries, and on to the exterior upon the xivth segment. There is no receptaculum ovarum. The spermathecae are two pairs, which are large and oval in form; each narrows abruptly to form a very slender duct of considerable length; there are no diverticula.

2. *Gordiodrilus robustus*, sp. n. (Pl. VII. figs. 4, 5, 6 B.)

I have investigated three specimens of this species; it is a native of Lagos, West Africa. Two individuals were studied by means of longitudinal sections; the third was dissected.

External Characters.

The species is a small one, measuring only 32 millim. after preservation with Perenyi's fluid, followed by alcohol. The sizes of three of the species of *Gordiodrilus* described in the present paper are shown in fig. 6.

The individual of *Gordiodrilus robustus* selected for measurement consisted of ninety segments. The clitellum extends from the middle of the xiiiith to the end of the xviith segment; a narrow median area corresponding to the interspace between the ventral setæ is entirely unmodified. The clitellum is very thick, and stands out from the rest of the body in the living as well as in the preserved worm.

The setæ are strictly paired, and lie upon the ventral surface; the two lateral pairs are separated from each other

by an approximately equal distance ventrally and dorsally. On the vth, vith, and viith segments the setæ are considerably larger than those which follow. A more marked disparity, however, is seen in the ventral setæ of segments xii. and xiii. These are three or four times as large as the lateral setæ of the same segment, and as the setæ of the preceding and succeeding segments; they give a very marked character to the region of the body where they occur. In their shape they are like the setæ of the other segments of the body, which have the usual Lumbricid pattern. No peculiarities distinguish the clitellar setæ; the full number of setæ are present upon the clitellum.

The only apertures that I could distinguish upon the body of an individual cut open and mounted in glycerine were the atrial pores; and these are so little conspicuous that I only observed them after I had ascertained their position by means of sections. There are two pairs of atrial pores; as in the last species, they are upon two consecutive segments; but the segments are the xvith and xviiith. The pores lie just behind and to the outside of the outermost seta of the ventral couple.

Behind the male pores is an oval median papilla upon segment xix.; the epithelium covering this papilla is composed of very tall glandular cells with clear non-staining contents.

Internal Structure.

Above and behind the pharynx the septal glands are very conspicuous; in the vth, vith, and viith segments they form isolated masses attached to the septa dividing these segments. There is a well-developed gizzard in segment viii. In the ixth segment the single ventral calciferous pouch is placed*. It was not very well preserved in the specimens; but its structure appears to be identical with that of the pouch of *Gordiodrilus elegans*. The septa separating segments v./viii. are very thick; those between segments viii./xii., though thinner, are yet stouter than those which follow. There are two pairs of testes and two pairs of vasa deferentia corresponding to these, which remain separate till just before their external orifice. The testes and funnels of the vasa deferentia are as usual in segments x. and xi. The ovaries are in segment xiii., and the oviducts open on to segment xiv.; there are no receptacula ovarum.

* In another specimen, dissected since the above was written, the pouches of segment ix. were paired, though ventral in position; this species is, so far, a connecting-link between *Gordiodrilus* and *Pygmaeodrilus*.

The spermatothecæ have a somewhat unusual form. There are two pairs of these organs in segments vii. and viii. The pouch is lined with a single layer of columnar cells, covered by an exceedingly delicate layer of muscles. The pouch was invariably much crumpled; it was filled with an almost homogeneous coagulated mass, in which no spermatozoa could be detected. The pouch communicates with the exterior by a very long and slender duct (see fig. 4); the length of this duct is only paralleled among earthworms by the genus *Moniligaster*; it has thick muscular walls. The spermatothecæ are quite unprovided with diverticula.

3. *Gordiodrilus elegans*, sp. n.

(Pl. VI. fig. 1; Pl. VII. figs. 6 A, 7.)

From the same locality as that which produced the last species were a number of small slender worms, which I took at first for immature examples of *Gordiodrilus robustus*. They prove, however, to belong to a distinct though closely allied form.

The principal points of difference apart from the shape concern the spermatothecæ and the alimentary canal.

The pores of the atria and of the vasa deferentia appear also to be on different segments; in the present species they certainly lie upon segments xviii. and xix.: that is to say, the first pair open on to segment xviii., the second pair and the vasa deferentia open, independently of each other, on to segment xix. In *Gordiodrilus robustus* it is the xviith and xviiiith segments which appear to bear these pores; but as the sections were rather broken, owing to the presence of grit in the alimentary canal, I may have made a mistake of one segment.

In any case, this species can be distinguished by the entire absence of a gizzard and by the much shorter duct of the spermatothecæ (cf. figs. 4 and 7).

External Characters.

The shape of *Gordiodrilus elegans* as compared with the last two species can be seen in fig. 6; it is a much more slender worm than *G. robustus*, and is not nearly so long as *G. tenuis*. As in both these species, the male pores open upon an area which is marked off from the rest of the body. When the body-wall is examined as a flat preparation in glycerine, the area (see fig. 1) is seen to be circumscribed by a ridge with an undulating outline. The appearance of this area is at first sight remarkably like the area surrounding

the male pores of some Eudrilids; and one's first idea about an earthworm coming from tropical Africa is that it must belong to that family. The microscopical examination of this area shows that it is quite unlike anything that occurs in the Eudrilidæ; it is much more like what we find in *Benhamia*; and *Gordiodrilus* should possibly be referred to the same family, *i. e.* the Acanthodrilidæ. The male genital pores are, as in the other species of this genus, three on each side; two pairs of atrial pores, and one pair of apertures separate from the atrial pores by which the vasa deferentia open on to the exterior. These pores are situated on the ridge itself, and not on the area which it bounds. The position of the pores is shown in fig. 1. *Gordiodrilus robustus* is to be distinguished from *G. elegans* no less than from *G. tenuis* by the presence of copulatory papillæ upon segment xix. I could find no trace of such papillæ in the present species. Possibly their absence is to be explained by the strongly developed ridge which I have just described; the sucker-like structure which is thus formed may be sufficient to cause the worms to adhere together during copulation, and render unnecessary any special papillæ performing the same function.

The setæ of the present species are strictly paired and ventral in position. There is no difference in size between the setæ of the dorsal and lateral couples, nor are there any particular segments upon which the setæ are enlarged; in these points *Gordiodrilus elegans* differs from both its congeners. Furthermore the ventral setæ of segments xviii. and xix. are absent in the fully mature worm, while these same setæ are present in the other species. Neither are there any special penial setæ to take their place. The clitellum occupies segments xiii.-xviii.; it is only developed dorsally and laterally; ventrally there is an area left of which the epithelium is unmodified.

Internal Structure.

In the anterior part of the body a number of the inter-segmental septa are specially thickened; the first of these is that which divides segments v./vi.; the last is between segments ix./x.

The vascular system appears to be chiefly remarkable for the fact that there are only two large transverse vessels uniting the ventral and dorsal trunks; these lie in segments x. and xi., and have distinctly muscular walls; they are very conspicuous in the living worm.

The alimentary canal is, as has been already remarked,

entirely without a gizzard. The septal glands are well developed, and extend back as far as segment vii.; they have the same structure as in other *Oligochæta*.

In the ninth segment is, as in all the other species of the genus, a single median diverticulum of the œsophagus. I have reserved the description of this organ till now, as it happened to be better preserved in this species than in the two foregoing. I believe that the structure is identical in the other species; it certainly is in the next two. The pouch is egg-shaped, the cæcal extremity being directed forwards. There is no trace that I could detect of a formation of the pouch out of two halves; it is a single structure accurately median in position.

The septum separating segments ix./x. closely invests the pouch ventrally, so closely that it is easy to mistake it for the actual walls of the pouch. The real wall of the pouch is excessively delicate, consisting of a fine nucleated membrane which represents the peritoneum. The lumen of the pouch is, where it communicates with the œsophagus, very narrow; it then becomes wider and afterwards narrower again. The lining epithelium is different in character from the œsophageal epithelium, as may be seen in the accompanying figure (fig. 2). This epithelium appears to be composed of very narrow and close-set cells; in a given section but few of these, in relation to their total number, were furnished with a nucleus. This leads me to infer that the cells are considerably broader in one direction than in another, that they have in fact the form of longish narrow plates. This epithelial sac is not immediately surrounded by the delicate peritoneal investment of the organ already referred to. Between the two lies a mass of cells (fig. 2), which forms the bulk of the organ. That this mass, which lies between the outer investment and its epithelial lining, is composed of cells, can only be inferred by the presence of numerous nuclei; no cell boundaries whatsoever could be detected. The nuclei in question are numerous, small, and darkly staining. The faintly staining substance, in which they are imbedded, has a distinctly reticulated appearance—not perhaps quite so coarse as is shown in the figure. It is traversed by numerous blood-vessels, which arise either directly from the peri-œsophageal blood-plexus, or indirectly from a sinus itself in communication with that plexus, but lying beneath as well as above the epithelial lining of the pouch. These capillaries, which are very abundant, collect to form a blood-vessel lying on the ventral side of the calciferous pouch. This vessel corresponds to the pair of

similarly placed vessels which occur in the Eudrilidæ. The calciferous pouch is thus very vascular, fully as much so as the tract of œsophagus from which it arises. This, however, is not all that I have to say about the minute structure of this organ. The lumen of the pouch does not end blindly a little way in front of the cæcal extremity of the pouch; it is prolonged up to nearly the end, becoming gradually narrower. Just before the extremity of the gland it becomes slightly wider, and *communicates with a network of fine tubes spread over the greater part of the periphery of the gland. These tubes have an intra-cellular lumen.* They lie just below the blood-vessel which collects and carries away the blood from the pouch, and are of such small calibre as to be very inconspicuous. They are shown in fig. 2 in a longitudinal and vertical section of the pouch. Fig. 3 represents a portion of the network seen in tangential section through a portion of the periphery of the pouch. Both these figures show a structural feature of great interest if it proves to be as in those drawings. Fig. 3 is a drawing which I have endeavoured to make as accurate as possible of a portion of the network referred to. Fig. 8 is a compound figure of which the details have been filled in from more than one section. In fig. 3 *the network is shown to be continuous with a tube (a), which is part of the nephridium of the ninth segment.* I confess at once that only one specimen out of six series of sections of this and the following species shows the connexion between the nephridium and the intra-cellular network of the calciferous pouch. But I can see no reason for doubting the accuracy of my drawing; moreover in the other sections there were no appearances in any way opposed to this interpretation. If confirmed, this fact is evidently of some importance. I ought to mention, however, that the nephridia of the ninth segment, which I believe to be connected with the calciferous pouch, also open on to the exterior in the usual way. Before treating further of the connexion of the nephridia with the pouch, I may compare the pouch with similar structures in other *Oligochæta*.

Calciferous glands, œsophageal glands, or glands of Morren, as they have been variously termed, exist in nearly all earthworms. The only family from which these structures are consistently absent is that of the Perichætidae. Among the lower *Oligochæta* the Enchytreidæ alone possess similar glands. Dr. Michaelsen, of Hamburg, distinguishes two kinds of these glands in earthworms, which he calls respectively "Kalkdrüsen" and "Chylustaschen." To the latter belong the unpaired median pouches of the Eudrilidæ, which were

first described by myself* in the genus *Eudrilus*. These diverticula of the gut, Dr. Michaelsen supposes, as well as the corresponding organs of the Enchytreidæ, serve not to pour any secretion into the gut, but to absorb digested food. Thus their function would be different from that of the calciferous glands; it is well known that these latter produce a secretion consisting of crystals of carbonate of lime. The difference in outward appearance between the paired calciferous glands and the unpaired ventral pouches of *Eudrilus* and other Eudrilids is sufficiently striking to suggest a different function. The differences in histological structure do not appear to me to be so great. But in a specimen of *Eudrilus* recently examined by me the median pouches contained large crystals quite similar in appearance to the crystals found in the paired glands. I did not test them chemically. I am disposed to think that the two kinds of glands really belong to the same category. It will be noticed that they do not co-exist in the same segment. As to one series of glands being paired, the other unpaired, I do not attribute much importance to this. Neither does Dr. Michaelsen; for he places in the same category with the "Chylus-taschen" of *Eudrilus* &c. the paired diverticula of *Pygmaeodrilus*.

In the Enchytreidæ, moreover, they may be paired or unpaired. For this reason I do not lay much stress upon the existence of these ventral median pouches in *Gordiodrilus* as evidence of a close affinity with the Eudrilidæ. In a recent paper† I have described the branched and anastomosing lumen of two Eudrilids, viz. *Heliodrilus* and *Hyperiodrilus*, to be at the periphery of the organ intracellular. This appeared to me to be a necessary result of the folding and refolding of the lining membrane. In *Gordiodrilus*, however, it is different; I should rather compare the intracellular part of the gland with the dorsal median diverticulum of *Buchholtzia*‡. If a glandular structure has an intracellular system of ducts, one is tempted without more ado to put it down as of nephridial nature. Avoiding any undue prejudice of this kind there still remains the actual connexion of the intracellular part of the gland-pouch in *Gordiodrilus* with a nephridium. It may be, as was suggested to me, an unimportant matter due to the absorption of the intervening

* "Contributions to the Anatomy of Earthworms," Proc. Zool. Soc. 1887, p. 273.

† "On the Structure of two new Genera of Earthworms, &c.," Quart. Journ. Micr. Sci. vol. xxxii. p. 235.

‡ Michaelsen, "Ueber Chylusgefässsystem bei Enchytræiden," Arch. mikr. Anat. Bd. xxviii. p. 292.

wall; if the facts of this connexion are of morphological importance, and not the result of a mere accident, they are evidence that the cesophageal glands, like the "salivary glands" (mucous glands of *Acanthodrilus* &c.) and the anal glands in *Acanthodrilus multiporus*, are partly at least formed out of nephridia. The glands appended to the alimentary tract of *Oligochæta* would thus be for the greater part reducible to a common origin.

The nephridia of this species are enveloped in a very thick layer of peritoneal cells; there is no terminal vesicle at the extremity of the nephridium; the funnel opens as usual into the segment in front. The first nephridium is in the fourth segment; they continue thence without any interruption to the end of the body. The thick coating of peritoneal cells is found in all the species of *Gordiodrilus*, and gives to them their whitish colour. The cells are in so many cases loaded with spherical granules that not only the nucleus but sometimes the limiting membrane is concealed; some of these granules are, others are not, stained by the colouring reagent used. The anterior nephridia have not this thick coating of vesicular cells; the segment in which this investment is first apparent seems to vary. In one individual the nephridia of segment xiii. were the first to show an increased development of the peritoneum; in another I did not find these granular cells before the nephridia of segment xix.

The reproductive organs of this species are constructed upon the same plan as in other species. The testes are two pairs, in segments x., xi.; the ovaries a single pair, in xiii. There are no receptacula ovarum, and the oviducts have the usual relations. The sperm-sacs occupy segments ix.-xii. I need say nothing about the vasa deferentia and atria.

The spermathecae, on the other hand, are a little different from those of other species. The form and minute structure of one of these organs is illustrated in fig. 7, which represents a longitudinal section through the entire pouch, and is naturally compiled from a number of sections. The pouch (there are two pairs, in segments vii., viii.) consists of two parts, firstly of a wide caecal pouch, secondly of a narrow duct connecting this with the exterior. At the junction of the two is a pair of small diverticula, one on each side. One of these two is longer than the other, though both are in point of size rudimentary. The distal pouch is round or oval in form and thin-walled; it is lined by columnar epithelial cells and covered externally by a thinnish layer of fibrous appearance with interspersed nuclei. In the diverticula the cells are lower. There was no indication of the function which the

diverticula perform, as the pouch was quite devoid of sperm. I have often pointed out that, when diverticula are present, the sperm is nearly, if not quite, invariably stored in them and absent from the main pouch. The epithelium also of the diverticula is commonly different in structure from that of the pouch into which the diverticula open. However, there was nothing of this kind to be observed in *Gordiodrilus elegans*. Between the points where the diverticula open and the exterior the spermatheca is narrow; but this narrower portion is by no means so long as it is in *Gordiodrilus robustus* (cf. figs. 4 and 7). It is ensheathed by a very thick layer of muscles, which are arranged in two directions. There is a single layer of stoutish fibres which pass round the tube and must act as a compressor, serving perhaps to eject the sperm. This layer of muscles, as shown in the figure, is not in contact with the lining epithelium of the tube. Whether this is or is not due to reagents I am unable to say. It suggests the possibility of a protrusion of the pouch. The outer layer of muscles is thick; it has a longitudinal direction, and in contracting would tend to protrude the pouch. Outside the two muscular layers is the peritoneal layer, which has the appearance of connective tissue and is provided with numerous nuclei; it is this layer alone which covers the pouch distally.

4. *Gordiodrilus ditheca*, sp. n. (Pl. VII. fig. 8.)

Among the specimens of the last species was a single individual which showed an interesting difference from the others. There was only a single pair of atria present, and in correspondence with these only a single pair of spermathecae. In other respects the individual agreed absolutely with *Gordiodrilus elegans*.

The question is whether the absence of the atria of segment xvii. and of the spermathecae of segment viii. constitutes a specific character. It might possibly be regarded as merely a variation. This case is quite analogous to that of the earthworm which I described some years ago* under the name of *Neodrilus monocystis*. That worm agreed in almost every particular with *Acanthodrilus dissimilis*, including even the remarkable alternation from segment to segment of the nephridiopores. It only differed in having but one pair of atria and one pair of spermathecae. But the spermathecae

* "Observations on the Structural Characters of certain new or little-known Earthworms," Proc. Roy. Soc. Edin. 1887, p. 157.

differed in the form of the diverticulum. My description of *Neodrilus* has recently * been confirmed and extended by Mr. Benham, and I myself have since received additional examples. It is clearly a distinct species, but not, as I now think, a distinct genus. Both this instance and that afforded by *Gordiodrilus ditheca* seem to show that the doubling of the atria is not quite so important a character as I and others have been hitherto inclined to regard it. The possession of one or of two pairs of atria need not, as I now think, hinder species from being placed in the same family, or even genus, if their other characters support such a juxtaposition.

5. *Gordiodrilus dominicensis*, sp. n.

(Pl. VI. figs. 2, 3.)

Of this species I have received about half a dozen examples from Kew; the habitat of the worm is the island of Dominica, in the West Indies.

The worms were all of the same size; one selected for measurement was 26 millim. in length by a breadth (at the head end) of 1 millim. It consisted of about eighty segments. The species is of the same build as *Gordiodrilus elegans*; and so alike are they in external characters that at first I thought that I was dealing with the latter species. It will be seen, however, from the following description that they are by no means identical.

External Characters.

The setæ are strictly paired and of the usual Lumbricid pattern. They are not modified in size or shape anywhere. Only the ventral pairs are absent upon the xviiith and xixth segments where the atrial pores open. The anterior segments are narrower—have a less antero-posterior diameter—than those which follow; from and including the seventh segment each is divided by a furrow into two parts. This furrow as nearly as possible coincides in position with the setæ. Further back still the segments are marked by more numerous furrows.

The prostomium is continued by furrows to nearly the posterior boundary of the buccal segment.

The nephridiopores are in front of the lateral pair of setæ; they can usually be fixed to one or other of the two setæ of the pair, and in fact show an alternation in position; some-

* "Notes on Two Acanthodriloid Earthworms from New Zealand, Q. J. M. S. vol. xxxiii, p. 289.

times they are in front of the outermost of the two setæ, sometimes in front of the innermost.

The atrial pores are, as in *Gordiodrilus elegans*, upon segments xviii. and xix. From these segments the ventral pairs of setæ have disappeared. The pores are borne upon two projecting folds of epithelium, which seem to have much the same structure as in the last species. The external characters are thus hardly different from those of *Gordiodrilus elegans*.

Internal Structure.

The internal structure, while agreeing in most particulars with that of the last-mentioned species, presents nevertheless quite recognizable points of difference.

In the alimentary canal the buccal cavity occupies the first two segments and a part of the third. The supra-oesophageal ganglia which lie in the third segment mark the commencement of the pharynx; the pharynx has, as usual, a strongly muscular dorsal wall and occupies only one segment—the fourth. The oesophagus passes from here to the xiiiith segment, in which the intestine commences, and is divisible into two regions. The first part, occupying segments iv.–viii. inclusive, is very slightly vascular and the epithelial lining is much folded; after the viiith segment the walls of the oesophagus are very vascular and not so much folded; but this latter character, though it occurred in two specimens examined, may be perhaps accidental. If I had dissected the worm only, instead of seeking the results obtained by dissection by a continuous series of longitudinal sections, I should have put down the pharynx as occupying a much larger number of segments than one. The tract of oesophagus in fact which immediately follows the pharynx is covered dorsally with a dense mass of septal glands; these are absent from the pharynx itself. These septal glands, which are so common among the lower Oligochaeta, extend back as far as the viiith segment, and there are traces of them in the viiith; but it is only in the vth segment that they form a dense investment of the gut. In the ninth segment the oesophagus gives off the single ventral diverticulum which distinguishes this from any other genus of Oligochaeta.

The relations of the calciferous pouch are precisely as in the last species; in fact the description I have already given of this body was largely drawn from sections of the present species.

Running along the dorsal side of the œsophagus the supra-intestinal vessel first becomes evident in this region of the body. *Gordiodrilus dominicensis* has the two hearts of segments x. and xi. that are found in other species.

There are three specially thickened septa which separate segments vi./vii., vii./viii., and viii./ix. The septa lying between v./vi. and ix./x. are also tolerably strong.

The nephridia are paired; they commence in the vth segment, and are present in the genital segments. From the tenth segment onwards they are invested, as in the other species of the genus, with a mass of clear peritoneal cells. The funnels opening into the segment in front of that which bears the external aperture were seen. *I could find no blood-vessels upon the nephridia* either in sections or in teased glycerine preparations of the organs. This statement applies to the other species also.

The reproductive system appears to differ from that of all other species of the genus in the total absence of spermathecae. We are at the present time acquainted with several *Oligochæta* which have no spermathecae; for the most part these belong to genera where the spermathecae are normally present. There is therefore nothing extraordinary in their absence from *Gordiodrilus dominicensis*, though present in the other species of the genus. The testes are in segments x. and xi. In one out of the two or three individuals examined by me there were two pairs of ovaries, though but a single pair of oviducts occupying the usual position.

In other particulars the reproductive organs are quite like those of *Gordiodrilus elegans*.

It will be clear from the foregoing description that this species differs but slightly from *G. elegans*. The only well-marked point of difference is the absence of spermathecae. If I have not by some accident overlooked these structures their absence is of course sufficient to separate the two species.

III. DIAGNOSES OF THE GENUS AND SPECIES.

From the above anatomical description of the five species of the genus I attempt the following diagnoses:—

Genus **GORDIODRILUS**, gen. nov.

Small slender terrestrial Oligochæta, with paired setæ of the usual Lumbricid pattern. Clitellum variable, always inclu-

ding the male pores. Nephridia paired, and after the first few surrounded by a thick mass of peritoneal cells. Alimentary canal with a single median ventral diverticulum in segment ix.; gizzard generally absent; intestine without typhlosole. No subnervian vessel; two pairs of stout hearts in x., xi. Testes in x., xi., or x. only; atria two pairs (or one pair), with an epithelial lining only one cell thick opening on to two consecutive segments; vasa deferentia opening independently of atria; ovaries in xiii.; spermathecae two pairs (or one pair) in vii., viii., with no diverticula, or at most rudimentary diverticula. No penial setæ.

1. *Gordiodrilus tenuis*, sp. n.

Ventral setæ much larger than dorsal. Clitellum xiv.-xxvii. Male pores on xx. and xxi. One pair of testes.

2. *Gordiodrilus robustus*, sp. n.

Male pores on xvii. and xviii. A median genital papilla on xix. Gizzard present.

3. *Gordiodrilus elegans*, sp. n.

Male pores on xviii. and xix. Clitellum xiii.-xiv. Spermathecae with rudimentary diverticula.

4. *Gordiodrilus ditheca*, sp. n.

Male pores on xviii. only. One pair of spermathecae in vii., without diverticula.

5. *Gordiodrilus dominicensis*, sp. n.

Male pores on xviii. and xiv. No spermathecae.

The following table shows the principal resemblances and differences between the five species:—

| | <i>G. tenuis</i> . | <i>G. robustus</i> . | <i>G. elegans</i> . | <i>G. tillicea</i> . | <i>G. dominicensis</i> . |
|------------------------|---|--------------------------------------|---|-------------------------------|--------------------------------------|
| <i>Sete</i> | Dorsal pair much larger than ventral. | Paired and equisized. | Paired and equisized. | Paired and equisized. | Paired and equisized. |
| <i>Gizzard</i> | Absent. | Present. | Absent. | Absent. | Absent. |
| <i>Atria</i> | Two pairs opening on to segments xx. and xxi. | Two pairs opening on to xvii, xviii. | Two pairs opening on to xvii, xviii. | One pair opening on to xviii. | Two pairs opening on to xvii, xviii. |
| <i>Spermatotheca</i> . | Two pairs without diverticula. | Two pairs without diverticula. | Two pairs with rudimentary diverticula. | One pair without diverticula. | ♀ Absent. |
| <i>Clitellum</i> .. | Occupies segments xiv.-xxvii. | xiii.-xvii. | xiii.-xviii. | xiii.-xvii. | xiii.-xviii. |

IV. AFFINITIES OF THE GENUS *GORDIODRILUS*.

The relationships of this genus are not very plain. I was at first disposed to place it near *Acanthodrilus*, on account of the double atrial pores and the independence of the opening of the vasa deferentia. It does not, however, in other respects show any likeness to that genus; and the points of resemblance cited are not perhaps so important as they at first appear.

With the Eudrilidæ there is not very much that this genus has in common. Indeed the only structure which at all recalls that family is the ventral calciferous pouch of segment ix., unless, that is to say, the large ventral setæ of *Gordiodrilus tenuis* be regarded as a further resemblance.

The description which has been given above of these ventral pouches shows that there is no great agreement in detail with any Eudrilid; but it might be considered to represent a somewhat degenerate "Chylustasche," differing principally in the reduction of the folding of the lining membrane. The question is, whether the existence of the unpaired median calciferous gland is an important resemblance or not. It is true that the Eudrilidæ alone agree with *Gordiodrilus* in possessing median ventral pouches. Among the Enchytreidæ a median dorsal pouch is met with.

The reduction of the atria to a single pair in *Gordiodrilus ditheca* is a fact of some importance: it is paralleled by the similar reduction met with in the earthworm named by myself *Neodrilus monocystis*; in all other respects *G. ditheca* agrees as closely with the other species of the genus in which I have placed it as does *Neodrilus* with *Acanthodrilus*. These facts seem to indicate that it is not necessary to lay too much stress upon the duplication of an organ. Plenty of other similar instances will at once occur to any one conversant with this group.

The atria of *Gordiodrilus* in their minute structure most resemble those of *Ocnerodrilus*; these two genera, together with *Moniligastra*, are the only terricolous forms which agree with the aquatic genera in having but a single row of cells forming the lining of the atrium. I am inclined to believe, however, that the simplification of the structure of the atrium thus produced is not necessarily a proof of affinity with the only other genus in which this has taken place in an exactly similar way; but as in other respects the genera *Gordiodrilus* and *Ocnerodrilus* are not far apart, and as they must both be undoubtedly referred to the large family CRYPTO-

drilidæ, it seems on the whole probable that they are nearly akin. Provisionally therefore I include the new genus described in the present paper in the family Ocnerodrilidæ. I am not at all certain, however, that the likeness is not the result of a convergence due to simplification in the same direction. Both *Ocnerodrilus* and *Gordiodrilus* are chiefly to be defined by negative characters.

V. EXPLANATION OF THE PLATES.

PLATE VI.

- Fig. 1. Gordiodrilus elegans.* Ventral surface of genital segments represented as being semitransparent. *at*, atria; *v.d*, vas deferens.
Fig. 2. Gordiodrilus dominicensis. Ventral calciferous gland. *l*, lumen of gland opening into œsophagus; *n*, nephridium, apparently continuous with intracellular part of lumen of gland; *s*, inter-segmental septa.
Fig. 3. The same. A portion of intracellular part of lumen of calciferous gland viewed superficially and showing connexion with nephridium (*n*).

PLATE VII.

- Fig. 4. Gordiodrilus robustus.* A spermatheca.
Fig. 5. The same. Longitudinal section through genital segments, to show external orifice of atria (*at*.) and vas deferens (*♂*). *f*, inter-segmental furrow; *s*, seta.
Fig. 6. A. *Gordiodrilus elegans*; B. *G. robustus*; C. *G. tenuis*; all of natural size. *♂*, male pore; *p*, genital papilla.
Fig. 7. Gordiodrilus elegans. Spermatheca.
Fig. 8. Gordiodrilus ditheca. Longitudinal horizontal section through œsophagus (*œs*.) and calciferous gland (*Cac*.). *S*, septum; *T*, testis; *H*, heart; *Per.*, peritoneal cells; *a*, glandular cells surrounding calciferous gland; *vac*., vacuole.

X.—Notes from the St. Andrews Marine Laboratory (under the Fishery Board for Scotland).—No. XIII. By Prof. M'INTOSH, M.D., LL.D., F.R.S., &c.

[Plate VIII.]

1. On the Eggs and young Stages of the Sand-eels.
2. On the Ova and Larvæ of certain Pleuronectids.
3. On *Clymene ebiensis*, Aud. & Ed.
4. On the Atlanta-like Larval Mollusk.

1. On the Eggs and young Stages of the Sand-eels.

THE reproduction of the sand-eels has hitherto been involved in obscurity, though considerable attention has been given to the subject at St. Andrews for several years, *e.g.* by Mr. W. L. Calderwood and others. Similar investigations were carried out elsewhere by the late esteemed and conscientious observer,

Mr. Duncan Matthews, under the auspices of the Fishery Board for Scotland.

The eggs and larval forms of sand-eels for the most part have escaped observation, and it is possible that there is something peculiar in the habits of the adults at the spawning-period, and especially in connexion with the deposition of the ova. The latter have never been captured in the tow-nets, though these have often swept the bottom. They have also escaped notice in the dredge used on sandy ground, and in digging for the adults in the sand at extreme low water.

The literature on the subject, so far as known, is scanty. Parnell notes that the sand-eel (*Ammodytes tobianus*) spawns in September*, but that he could give no definite opinion with regard to *A. lancea*. Day observes that he found the ovaries of *Ammodytes lanceolatus* considerably developed in August, and concludes it spawns in autumn and winter. The reproductive organs of *A. tobianus*, again, were far advanced in August and September, and he mentions that Thompson procured some ready to deposit their spawn at the end of July; but he remarks that in some places they do so during the winter. "Couch considered the end of December the most common period; so probably they continue spawning through the last few months of the year, dependent on the temperature, becoming very poor in winter after breeding." The words of Couch are:—"It is in this retreat, concealed and sheltered with the sand of the shore, that this lance (*A. tobianus*) sheds its roe, the grains being scattered as it passes on; and in the west of the kingdom, at least, this process is accomplished at about the shortest days of the year." Buckland† mentions May and June on the authority of Blanchere, and the place of spawning the "sand." Möbius and Heincke give May as the spawning-season of *A. lanceolatus*, according to Bloch, and mention that Malm found a female with enlarged ova in June.

The general result of the observations made in former years at St. Andrews was that in May and June many examples of *A. tobianus*, not always the largest, have the ovaries well developed, but until this year no ripe specimen had been procured either by digging or other method of capture. Ripe males, however, have often been obtained, and, as in other groups, some of these have been comparatively small. Few ripe examples on the whole have been procured by digging, but, on the other hand, there is no

* 'Fishes of the Firth of Forth,' pp. 391-393.

† 'Report Sea-Fisheries of England and Wales,' p. 246.

evidence that they assume a more or less pelagic existence at the spawning-period.

By the aid of the Fishery Board for Scotland, additional facilities have lately been afforded for the examination of both species by seine-nets at Elie and at St. Andrews. From the former place (Elie) almost all the examples of *A. lanceolatus* have been procured, since it is rare at St. Andrews. Dr. Fulton also kindly forwarded ripe ovaries of an early specimen (May 20).

The specimens of *A. lanceolatus* were large—some exceeding a foot—and in fine condition. The enlarged ovaries in these stretch forward to the liver, and posteriorly extend some distance behind the vent. The organs are so closely applied as to appear connate, the respective sides, however, being separated by a deep furrow. In some a general enlargement of almost all the ova occurred, the majority having reached the stage at which a single oil-globule only is present, the greenish-yellow hue of the latter affecting the tint of the ovaries *en masse*. Yet none of these had the slight translucency characteristic of a perfectly ripe egg. In others, while the ovaries generally were enlarged, the ripe eggs were few in number and scattered singly at the surface of the ovaries. A few presented a continuous band of ripe eggs on the outer side of each ovary ventrally, and from the anterior to the posterior end, with or without a group of ripe eggs (one or two of which occasionally escaped externally) near the reproductive aperture. The specimens thus forwarded daily from Elie* showed few marked differences, unripe ovaries being as common at the beginning of July as at the beginning of June. So far as could be observed, no great exodus of eggs takes place suddenly, the diminution in the size of the ovaries occurring gradually.

In the most advanced males the testes occupied a similar area to that of the ovaries, but while at the beginning of June the sperms occasionally retained considerable activity on arrival, those at the beginning of July were in most cases either undeveloped or almost motionless. The general impression, indeed, was that their vitality was feeble. The testes in a few were diminished, while the centre contained crowds of sperms, showing that the organs were in full functional activity.

The spermatozoa are very minute, with a head that when highly magnified resembles a grain of rice slightly curved, so as to present a kind of hilum at one side. Neither end is

* By the skill and care of Mr. Rodger, Chief Officer of the Coast-guard.

tapered. The filiform tail is so attenuate that it is difficult to distinguish it.

As indicated, the ova varied in different examples. The larger developing (not ripe) ova in some were all about the same stage of advancement, though small ova occurred here and there throughout. The capsule (*zona radiata*) is tough, and contains, in the eggs approaching maturity, besides the nucleus, the minutely granular yolk, which has a series of small, deep greenish-yellow oil-globules distributed amongst it. In ovaries somewhat further advanced, the ripe ova had an average diameter of .7620 millim., and instead of the numerous scattered globules all had now coalesced into a single conspicuous oil-globule of a greenish-yellow hue measuring .1950 millim. in diameter. The capsule is thick, and may be divided into an external and an internal lamina. The outer surface is minutely areolated or papillose, the papillæ being evident as a distinct border at a fold of the zona, *e.g.* after rupture. In some the minutely complex folds resemble those of a microscopic *Meandrina*. The nature of this outer layer is still *sub judice*. It may be either a follicular growth or more probably the result of a special secretion for adhesion, though the latter at first sight would hardly be supposed to be so regular. It can easily be abraded from prominent folds of the egg, leaving the smooth and glistening zona beneath. The latter is a hyaline and minutely perforate layer, which assumes different appearances under examination, such as rows of dots or finely crossed lines. The micropyle is conspicuous in the form of a deep pit, from which radiate a series of long furrows.

When these eggs are removed from the ovaries and placed in sea-water they adhere to the bottom of the vessel, so that it may be inverted without detaching them. They are not, however, firmly fixed, since they can be loosened from the glass with a camel's-hair pencil or the point of a pipette. They adhere in the same manner to the forceps or a slide. In water they do not often adhere to each other, but do so slightly when placed in contact.

At the same period the majority of the most advanced examples of the lesser sand-eel (*A. tobianus*) at St. Andrews present considerably smaller ova than the foregoing; indeed, throughout June and July only a single female here and there is found in a ripe condition, yet perhaps hundreds are captured in a single sweep of the seine-net. These, however, are, as a rule, smaller forms than those captured by the same kind of net in the Forth, at Elie, where the ripe females are considerably more numerous. On the other hand, ripe males

are not uncommon amongst the specimens at St. Andrews—some of these being only four inches in length, or even somewhat less.

The ova of this species agree in general structure with those of *A. lanceolatus*. In the early condition the capsule (*zona radiata*) encloses only minutely granular yolk, no special oil-globules being visible. The latter subsequently become distinct, and by-and-by coalesce into a single large oil-globule, as in the latter species. The colour of the globule, however, is different, being of a honey-colour or faint yellowish brown.

The spermatozoa are more minute than in *A. lanceolatus*, but appear to have the same shape, viz. like a slightly curved grain of rice, no perceptible diminution occurring at the end from which the filament proceeds. Their vitality would seem to be as feeble as in that species.

Artificial fertilization was frequently performed with specimens sent by the courtesy of the Fishery Board from Elie, but at first without success. It is true certain changes ensued, but whether these were altogether due to partial fertilization, is an open question. A slight streaming of protoplasm occurred with the formation of a thick belt round the yolk. The perivitelline space also largely increased in size. Then a conical elevation of the protoplasm formed a disk, but no segmentation took place. The persistent feebleness of the sperms after the journey showed that it was necessary to fertilize on the spot—immediately after landing at Elie. This was accordingly done, with the result that after the usual streaming of the protoplasm on the surface of the yolk, the increase of the perivitelline space, and the formation of the prominent conical disk, segmentation ensued. Towards the end of July a considerable number of ova were successfully hatched, so that the larva was satisfactorily identified with those abundantly procured by the various nets from the early part of the year onwards. Dr. Fullerton also hatched them at the Laboratory at Dunbar at the same time.

The constant employment of the various tow-nets at different depths throughout the year shows that few forms of larval, post-larval, and young fishes are more abundant, more generally distributed, or occur over a longer period than the sand-eels. At St. Andrews they appear in February, and the larval and post-larval forms are found onward through March, April, May, June, July, and August, showing that a constant succession of eggs and young are kept up throughout this long period.

2. *On the Ova and Larvæ of certain Pleuronectids.*

The ova of most of the pleuronectids have been developed at St. Andrews, but until recently those of the halibut and long-rough dab have been enveloped in mystery. The large eggs of the former, which Mr. Holt and I find to measure from 3·5 to 3·9 millim. or even more in diameter, have been procured by the former energetic observer at Grimsby, and about the same time by Mr. Mackie, an officer of the Fishery Board for Scotland, stationed at Peterhead—thanks to the exertions of Dr. Fulton, the scientific secretary of the Board. Last year again, Mr. Holt, when engaged off the west coast of Ireland, proved that the egg with the large perivitelline space (egg of Pleuronectid B)*, with which we had long been familiar, was that of the long-rough dab. These ova were frequently encountered in considerable numbers during the trawling-expeditions of 1884, and Mr. Cunningham described and figured the same form before hatching†. Further observations on the egg and the larva were given in the "Pelagic Fauna of St. Andrews Bay"‡, and in the "Researches"*; where an account of the larval condition, with a coloured figure by Prof. Prince, occurs.

The ova of the pleuronectids group themselves in three series, viz.: (1) those with a perfectly transparent yolk devoid of oil-globules; (2) those with a single oil-globule which moves freely in the yolk; (3) those with groups of small or scattered larger oil-globules. In the first series are the eggs of the halibut, long-rough dab, plaice, lemon-dab, craig-fluke or witch (*Pleuronectes cynoglossus*), dab, and flounder. In the second group are the ova of the turbot, brill, megrim, scald-fish, and topknot. In the third series are the soles, the common species (*Solea vulgaris*) having a ring of groups of minute oil-globules, and the others scattered oil-globules of larger size.

Though ripe eggs of the turbot were procured in the trawling-expeditions of 1884, additional information has since been obtained. The ripe unfertilized ova have a diameter of from ·99 to 1·06 millim. (Holt). Closely allied eggs, which have a diameter of about ·9906 millim., have been captured in the tow-nets in summer for years, but their precise identification with those of the turbot has not been satisfactorily made out by Mr. Holt or myself. The egg and larva

* Trans. R. S. E. vol. xxxv. iii. p. 853, pl. x. fig. 8, and pl. xviii. fig. 2.

† Trans. R. S. E. vol. xxxiii. i. p. 105, pl. vii. fig. 2 (1887).

‡ 7th Ann. Rept. Scottish Fishery Board, p. 270, pl. iii. figs. 1, 2, & 3.

are figured in the "Researches" * by Prof. Prince, the latter being recognized by the position of the oil-globule in the yolk after hatching, viz. considerably in front of the posterior border of the yolk-sac, which, moreover, is finely reticulated, and by the yellowish coloration. A preanal portion of the marginal fin is present.

The eggs of the brill, which have a diameter of 1.33 millim., were recognized by Raffaele †, and subsequently at St. Andrews, where they were for the first time hatched, and the larva figured and described ‡. As, however, the ova had been fertilized with the milt of a turbot, since no male brill could be procured on the occasion, some uncertainty was expressed as to the condition under ordinary circumstances. Further experience this season has shown that the description and figures are fairly reliable for the species. Both the turbot and the brill have a smaller oil-globule than the sail-fluke (*Arnoglossus megastoma*).

3. On *Clymene ebiensis*, Aud. & Ed.

In the edition of the 'Règne Animal' by the disciples of Cuvier, Audouin and Milne-Edwards introduced as the type of the 'Climènes,' Savigny (an abbranchiate setigerous group which they associated with the Lumbrici), and for the accompanying illustrations on pl. xxii., a new form which they termed *Clymene ebiensis*. No description further than the explanation of the six figures and a footnote is given, but there is sufficient to recognize the form. It was found by the authors "à l'île des Ebiens" on the shores of Brittany, and is characterized by the pyramidal form of the cephalic segment and the absence of cirri on the anal funnel. In the plate the annelid with its tube of the natural size, two views, dorsal and ventral, of the cephalic lobe, and a figure of the posterior end of the body are given, besides four of the hooks magnified. The cephalic region is diagnostic, but the posterior end, or, as it is called, the "Extrémité anale," represents only the ruptured constricted region between the two preanal bristled segments, while the figure of the hooks is scarcely diagrammatic. The tube is evidently of sand-grains cemented together.

In his 'Familien der Anneliden' § Grube characterizes

* Trans. R. S. E. olim cit. pl. v. fig. 4, and pl. xvii. fig. 4.

† "Le nova Gallegiantii, &c.," Mitth. Zool. Stat. Nap. viii. p. 48, tav. 4. figs. 8 &c.

‡ 9th Ann. Report S. F. B. p. 317, pl. xiii. figs. 1-3.

§ P. 157.

the species doubtfully as having a small anal funnel, and places it under the division of those with the plate of the head-lobe small. Sars again thought his *Clymene Mülleri** somewhat approached *Clymene ebiensis*, Aud. & Ed., but such referred only to the cephalic lobe, since the Norwegian form had an anal cup with from fifteen to twenty-three or more cirri. De Quatrefages located the species under his genus *Leiocephalus*, which he instituted for those with a head terminating in a papilla, and with no or hardly any cephalic plate. The anterior region of the body is composed of three elongate segments, the feet are biramous, the inferior division indistinct. He characterizes the head as acute, protracted, with the cephalic lobe almost absent. The first segment, moreover, has no superior division. Kinberg† gave two foreign genera (*Chrysothemis* and *Sabaco*) with a comparatively simple anal funnel, but there is nothing else in their structure to associate them with the present species.

Grube, in his remarks on the group ‡, pointed out that for a proper classification of the Maldanidæ both ends of the body are necessary, and therefore the precise position of Audouin and Milne-Edwards's *Clymene ebiensis* is uncertain. He would in the meantime decline to place *C. ebiensis* under the genus *Leiocephalus*, De Quatrefages, and thought the species perhaps identical with *C. intermedia* (which the examination of a complete specimen shows that it is not). He mentioned two species with smooth anal funnels, viz. *C. urceolata*, Leidy§, and *C. leiopygos*, Grube. The latter will be mentioned elsewhere; while the number of the segments, their condition as regards bristles, and the large urceolate anal funnel of the former leave doubts as to its identity with *C. ebiensis*, even after allowing the necessary margin for imperfect description.

Clymene ebiensis was next alluded to by the author||, a specimen, incomplete posteriorly and in its tube of coarse sand, having been dredged by the late Dr. Gwyn Jeffreys in the Outer Haaf, Skerries, Shetland (75-80 fathoms), in June 1867. "It is recognized by the pointed snout, the somewhat swollen anterior segments, and the absence of the usual frontal flattening. The shape of the hooks is peculiar, the chief fang being short and somewhat flattened." It was also

* Ann. Nat. Hist. 2nd ser. vol. xx. p. 156 (1857).

† Öfversigt af K. Vetensk.-Akad. Förhandlingar, 1806, pp. 340, 341.

‡ Schlesischen Gesellsch. f. nat. Cult. 1867; and Ann. Nat. Hist., Dec. 1868 (4th ser. vol. ii. p. 391).

§ Marine Invert. Rhode Is. and N. Jersey, p. 145 (1855).

|| Trans. R. S. E. vol. xxv. p. 422 (1869).

stated that it was allied to Grube's *Clymene leiopygos*, from Cherso *, though of course this diagnosis rested on the characters of the anterior region only. The acquisition of a perfect specimen, however, shows that Grube's species differs in the number of bristled segments, which are twenty-three, as well as in the form of the anal cup and the preanal segments. The anal cup, moreover, follows the last bristled segment, and thus materially diverges from the condition in *Clymene ebiensis*. It was subsequently procured in the 'Porcupine' expedition of 1870, at 305 fathoms in the Atlantic, but in this specimen also the posterior region was absent.

Théel's *Prawilla polaris* † has the same number of bristled segments, and the two or three last are devoid of these organs; but the otherwise smooth anal funnel has a small ventral cirrus, and the cephalic segment of course wholly differs. Hansen's *Clymene Koreni* ‡, another form with a smooth anal funnel, has only eighteen bristled segments, and the cephalic plate is like that in *Maldane*. The *Clymene cirrata* of Ehlers § has an anal plate with four long cirri, though the margin is otherwise smooth, and the cephalic lobe has broad flat lateral plates.

The anal plate of *Nicomache McIntoshii* of Marenzeller || is smooth, but it is flattened and otherwise quite different from the condition in the present species.

The examination of a complete specimen (Plate VIII. fig. 1) in spirit, courteously sent by Mr. Hornell, of Sinel's Laboratory, Jersey, has enabled me to clear up the ambiguity attached to the species, and more especially to ascertain the character of the anal funnel.

The cephalic lobe in this example, which Mr. Hornell says was six inches in length, has a dense series of minute brownish eyes in the preparation—visible from the dorsum on each side of the snout (Plate VIII. fig. 2), but disappearing by passing under the pointed tip. They extend on the under surface (Plate VIII. fig. 3) forward to the apex of the snout. In the other two examples no eyes can be seen. The curiously aberrant *Branchiomaldane Vincentii* of Langerhans, from the Canaries, shows similar groups of eyes on the dorsum of the

* Archiv f. Naturgesch. 1860, p. 91, Taf. iv. figs. 3, 3 a, 3 b.

† Kongl. Sv. Vet.-Akad. Handl. Bd. xvi. no. 3, p. 58, pl. iv. figs. 52 56 (1879).

‡ Norwegian N. Atlantic Exped. p. 40, pl. vi. figs. 1-5 (1882).

§ Florida-Anneliden, p. 182, Taf. 46, figs. 10-13.

|| "Polychäten d. Angra Pequena-Bucht," Zool. Jahrbüch, Bd. iii.

cephalic segment*. The median ridge on the dorsum runs smoothly into the general surface posteriorly, and the aspect of the parts varies according as the lateral flaps are erect or flattened. The lobe is comparatively short, and is marked inferiorly by the commencement of a median ridge, which is continued along the body to the margin of the anal funnel. The separation between it and the succeeding segment is only slightly indicated. The second segment is about a third longer than the cephalic lobe, and bears, about a fifth behind the anterior border, a small tuft of bristles and three hooks, the crowns of which are less elaborately formed than the same organs posteriorly. The third segment is still more elongated, and like some of the segments which follow is distinguished by an anterior whitish region, the bristles and hooks being at the posterior border of the latter, viz. about the anterior fourth of the segment. The two succeeding segments are similar, but the sixth and seventh are somewhat shorter and thicker—all, however, in the preparation showing the free fold of the anterior border, which in a manner ensheaths the posterior end of the preceding segment. The eighth has also the free and densely white anterior margin intensified by the dark hue of the region behind, and the bristles and hooks are similarly placed. Posteriorly a change in the arrangement of the segment-junction occurs, since the densely whitish region of the ninth segment passes slightly forward on it ventrally, so that the free margin so characteristic of the preceding segments is lost. The anterior border of this curved white region, however, really marks the segment-junction, though in the specimen from Jersey the arrangement is not so distinct as in the others, probably from the less perfect preservation. The bristles and hooks of the short ninth segment are situated posteriorly, and thus a change in the position of the organs is inaugurated. The segment-junctions are clearly behind this and all the remaining bristle-tufts, that is, from the tenth (inclusive) to the twenty-third, the last five or six segments being considerably elongated. The bristle-bundles and rows of hooks in this division of the body are conspicuous, and placed a little in front of each junction. The anal division (Plate VIII. fig. 4) appears to be composed of six segments, four of these (24th, 25th, 26th, and 27th) having slight elevations or papillæ to indicate the position of the bristle-tufts and hooks of the other segments, which are here absent. The terminal rim is not

* "Ueb. einige canarische Anneliden," *Nova Acta Acad. Cæs. Leop.-Car. Bd. xlii. No. 3, p. 116, figs. 21 a &c.*

much expanded, has a perfectly smooth edge, and the anal cone is in the centre.

The bristles have the usual microscopic structure, and the anterior hooks differ from the posterior in the shape of the crown and in the absence of the process under the great fang. The bristles and hooks of the posterior segments, viz. from the thirteenth to the twenty-third, are best developed.

No tube accompanied the specimen, but in the Zetlandic example the somewhat firm though friable tube is composed of sand-grains and minute fragments of shells cemented together by secretion, and it apparently resembles that figured by Audouin and Edwards.

4. On the *Atlanta-like Larval Mollusk*.

A few remarks were made under the Xth Series of "Notes from the Marine Laboratory" * on a minute *Atlanta-like* form which had been found in the tow-nets in St. Andrews Bay. A single example had been obtained, and it was only observed after having been immersed in spirit for a considerable time. In 1890 and in 1891, however, many specimens of the same form appeared, and the shell was observed to be elastic (uncalcified) and very minutely spinous, as shown in the accompanying drawing kindly made from the living animal by Mr. E. W. L. Holt (Plate VIII. fig. 5). The frequency of the form in the tow-nets, together with its minute size, showed that it probably was a larval stage of a mollusk not uncommon in the neighbourhood. Its relationship with the young *Lamellaria*, as described by Dr. A. Krohn, was indeed soon afterwards kindly pointed out to Mr. Holt and myself by Mr. M. F. Woodward.

A larva allied to the foregoing was first procured by Dr. A. Krohn at Messina, in March, and described as a new mollusk under the name of *Echinospira diaphana* †. The shape of this form, however, considerably diverges from that procured at St. Andrews, and the spines are much larger. Two years later the same author pointed out that the foregoing *Echinospira diaphana* was the larva of a pectinibranchiate Gastropod, and he subsequently described another species also obtained in the tow-net, in February, at Messina ‡. In the latter paper a full description of the horny shell and the structure of the larval mollusk are given; while the relationship of the form to the *Marseniidae* (*Lamellaria* &c.) is indi-

* Ann. Nat. Hist., January 1890, p. 47.

† Archiv f. Naturgesch. 1853, p. 223, Taf. xi. figs. i., ii.

‡ Ibid. 1857, p. 252, Taf. xi. figs. 1-4.

cated, with figures of the permanent as well as the larval shell*. The latter resembles the species procured at St. Andrews (Plate VIII. figs. 5 & 6), but differs from it in the size of the serrations on the ridges (fig. 7), those in the Messina specimen being much more minute.

The adult *Lamellarie* are not uncommon under stones between tide-marks, especially in rock-pools, and it might have been expected that the larval forms would have been sooner procured in the tow-nets. The more systematic use of the special bottom-net in recent years, however, seems to have been much more successful in this respect than either the surface or mid-water nets.

EXPLANATION OF PLATE VIII.

- Fig. 1.* *Chlymene ebiensis*, a little larger than natural size and viewed from the side.
Fig. 2. View of the dorsal surface of the cephalic segment. Enlarged under a lens.
Fig. 3. Ventral surface of the same region, showing the eyes and mouth. Similarly enlarged.
Fig. 4. Anal cone and funnel of the same species with the adjoining segments. Enlarged under a lens.
Fig. 5. Atlanta-like larva of *Lamellaria* in lateral view. The fine serrations of the edge are distinct. Magnified from life.
Fig. 6. View of the edge of the shell of the foregoing, so as to exhibit the double angle.
Fig. 7. Portion of the double angle, more highly magnified.

XI.—*Descriptions of Seven new Species of Birds from the Sandwich Islands.* By the Hon. WALTER ROTHSCHILD.

SOME specimens of birds belonging apparently to new genera and species have been forwarded to me by my collector, Mr. Palmer, and are of sufficient interest, I think, to be brought before the notice of naturalists.

Family *Anseridæ*.

Bernicla Munroii, sp. n.

Adult. Head and neck black, excepting a large patch which extends on the upper throat over the lower part of the

* A summary of the pelagic larval forms allied to the above is given in Bronn's 'Klassen u. Ordnungen' (Malacozoa), p. 1005, &c.

sides of the head and ear-coverts, which is pure white, but the black extends below the eye and over the chin; back, scapulars, and wing-coverts dull dark brown, the feathers edged with light buffy brown; rump black; upper tail-coverts white; quills blackish brown, becoming earth-brown on the terminal portion; tail black. Underparts greyish white, indistinctly barred with pale buffy ash; lower abdomen and under tail-coverts white. Bill and legs black; iris grey.

Total length about 21 inches, culmen 1·3, wing 13·1, tail 4·4, tarsus 3·1.

Hab. Kauai, Sandwich group.

Family Turdidæ.

Tatare familiaris, sp. n.

Adult male. Upper parts greyish brown, rather warmer in tinge on the rump, the sides of the head rather paler; wings and tail dark brown, the feathers externally margined with buffy brown; tail rounded; wings somewhat rounded, the first primary slightly shorter than the sixth. Underparts, together with the chin and throat, buffy white. Bill brown; legs fleshy brown; tarsus brown.

Total length about 5·75 inches, culmen 0·65, wing 2·55, tail 2·4, tarsus 0·92.

Adult female. Closely resembles the male.

Hab. Laysan Island, Sandwich group.

Family Drepanidæ.

Himatione Fraithii, sp. n.

Adult male. Upper parts vermilion-crimson, rather richer and more crimson in tinge on the head. Underparts similarly coloured to the upper parts down to the lower abdomen, which is dull ashy brown, fading into whity brown on the under tail-coverts; remiges and rectrices dull blackish brown, the external remiges narrowly margined with reddish white, the secondaries and wing-coverts margined with vermilion; rectrices also with narrow paler margins. Bill and feet black; iris reddish yellow.

Total length about 6 inches, culmen 0·55, wing 2·65, tail 2·4, tarsus 0·92.

Adult female. Closely resembles the male, differing only in the red being somewhat paler in tinge.

Young. General colour dull brown on the upper parts and

light ashy brown on the underparts ; many of the feathers margined with rich buff, giving a slightly mottled appearance ; wings and tail dark brown, the primaries narrowly and the secondaries broadly margined with rich brownish buff ; chin and upper throat orange-buff ; lower abdomen and under tail-coverts white tinged with buff.

Hab. Laysan Island, Sandwich group.

The present species somewhat resembles *Himatione sanguinea*, but differs from that species in being more vermilion and not blood-red in tinge of colour, and in having the lower abdomen and under tail-coverts pale ashy brown or brownish white, and not white ; besides, the bill is shorter and rather stouter in the present species than in *H. sanguinea*.

Family Fringillidæ.

Telespyza flavissima, sp. n.

Adult male. Head, neck, and underparts down to lower abdomen bright yellow, the crown rather darker ; upper parts generally yellow, slightly sullied with ashy brown, the rump and upper tail-coverts dull ashy brown, washed with yellow ; quills blackish brown, the primaries externally narrowly and the secondaries broadly margined with bright apple-yellow ; tail blackish brown, the feathers margined with apple-yellow ; lower abdomen and under tail-coverts dirty white, slightly washed with yellow. Bill blue ; legs brown ; iris greyish brown.

Total length about 6·5 inches, culmen 0·7, wing 3·3, tail 2·6, tarsus 2·05.

Adult female similar to the male.

Hab. Laysan Island, Sandwich group.

The present species somewhat resembles *Telespyza cantans*, Scott Wilson ('Ibis,' 1890, p. 341, pl. ix.), but has the head and the underparts rich yellow, the head lacking the brown markings, and the back is much yellower and lacks the dark brown markings of *Telespyza cantans*, which latter also comes from Laysan Island, and not from Midway Island, as stated in the 'Ibis' (*l. c.*).

RHODACANTHIS, gen. nov.

Bill stout and strong, broad at the base, the upper mandible sharp-pointed and curved as in *Psittirostra*, but not so

long; legs robust; first primary about equal to the fifth, the second and third equal and longest, the fourth a trifle shorter; tail slightly forked.

Obs. This genus is intermediate between *Chloridops* and *Psittirostra*, having the bill stout and large, as in the former, but longer and sharp-pointed, therein resembling the latter.

Rhodacanthis Palmeri, sp. n.

Adult male. Head and throat rich reddish orange; back and upper parts generally dull greenish olivaceous, brightening to dull dark orange on the lower rump and upper tail-coverts; wings and tail dark blackish brown, the feathers externally margined with deep yellow; lower throat and underparts dull orange-yellow, becoming much paler on the lower abdomen and under tail-coverts. Bill blue-brown; legs blackish grey; iris red.

Total length about 8.75 inches, culmen 0.82, wing 4.15, tail 2.95, tarsus 1.1.

Adult female. Crown, nape, sides of the head and upper parts generally olive-green, the lower rump and upper tail-coverts parrot-green; forehead brighter green than the rest of the head; quills and tail-feathers margined with dull parrot-green. Underparts dull light green, fading into dull white washed with green on the lower abdomen and under tail-coverts.

Young male. Resembles the female, but the fore part of the crown is orange-yellow and the throat is of a richer orange-green tinge.

Hab. Kona, Hawai, Sandwich Islands.

Rhodacanthis flaviceps, sp. n.

Adult male. Head, neck, and underparts generally apple-yellow, brighter and richer on the head and neck and greener on the underparts. Upper parts ashy green, becoming bright green on the lower back, rump, and upper tail-coverts; wings and tail dull blackish brown, the feathers externally margined with green. Bill blue-brown; legs grey; iris brown.

Total length about 7.5 inches, culmen 0.72, wing 3.8, tail 2.5, tarsus 1.0.

Adult female. Differs from the male in being much greener and duller in colour, only the forehead being yellow; the crown similarly coloured to the back. Underparts dull yellowish green.

Young male closely resembles the female, but has the underparts rather paler.

Hab. Kona, Hawai, Sandwich group.

Fam. Meliphagidæ.

VIRIDONIA, gen. nov.

Bill slightly curved, stout at the base, attenuating towards the tip, which is sharply pointed; wing rather broad, the first quill slightly shorter than the sixth; no bastard primary; tail rather short, nearly even at the tip; legs and feet stout; culmen about equal in length to the tarsus.

Viridonia sagittirostris, sp. n.

Adult male. Upper parts bright olive-green, rather paler and brighter on the sides of the head and upper tail-coverts. Underparts bright yellowish green; wings blackish brown, the primaries narrowly and the secondaries more broadly margined with yellowish green; tail blackish brown, with yellowish-green margins; under surface of the wings dark ashy, the quills margined with dull white on the basal half; margin of the wing tinged with yellow. Bill black; legs black; iris brownish grey.

Total length about 6·5 inches, culmen 0·9, wing 3·3, tail 2·1, tarsus 0·91.

Adult female. Resembles the male, but is rather duller in tinge of colour both on the upper and underparts.

Hab. Mauna Kea, Hawai, Sandwich group.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

January 27, 1892.—Dr. W. T. Blanford, F.R.S.,
Vice-President, in the Chair.

The following communication was read:—

“North Italian Bryozoa.—Part II. Cyclostomata.” By Arthur Wm. Waters, Esq., F.G.S.

The Chilostomata from the same localities were dealt with in volume xlvii. of the ‘Quarterly Journal.’ In the present paper a number of Cyclostomata are described, amongst the most interesting

being a new species termed by the Author *Diastopora brenholensis*, which has tubules similar to those of *D. obelia*. These are the only species in which tubules are known, and two modes of growth of the fossil seem to show that those who united under *Diastopora* erect and incrusting forms were right.

The ovicell by the side of the zoarium of *Hornera serrata*, described in the paper, is in a position new for the Cyclostomata.

March 23, 1892.—W. H. Hudleston, Esq., M.A., F.R.S.,
President, in the Chair.

The following communications were read :—

1. "On the Occurrence of the so-called *Viverra Hastingsia* of Hordwell in the French Phosphorites." By R. Lydekker, Esq., B.A., F.G.S.

The Author shows that *Viverra Hastingsia*, Davies, is common to the Oligocene of France and Hordwell, and finding that there is no character by which the lower jaw of the type of the latter can be satisfactorily distinguished from the type of *V. angustidens*, Filhol, he considers that *V. Hastingsia* is specifically inseparable from *V. angustidens*, and figures the cranium which is the subject of the communication under the latter and earlier name.

He gives a list of seven mammals known to be common to the Headon beds of Hordwell and the Isle of Wight, and the French Phosphorites.

2. "Note on two Dinosaurian Foot-bones from the Wealden." By R. Lydekker, Esq., B.A., F.G.S.

In this paper the third right metapodial (metacarpal?) and an associated phalangeal of a Sauropodous Dinosaur, obtained by Mr. C. Dawson from the bone-bed of the Wadhurst Clay, are described, and referred with doubt to *Mososaurus*.

The Author also discusses the relationship of *Acanthopholis platypus* from the Cambridge Greensand.

May 25, 1892.—W. H. Hudleston, Esq., M.A., F.R.S.,
President, in the Chair.

The following communications were read :—

1. "On *Delphinognathus conocephalus* (Seeley) from the Middle Karoo Beds, Cape Colony, preserved in the South-African Museum, Capetown." By Prof. H. G. Seeley, F.R.S., F.G.S.

The skull described in this paper is believed by Mr. T. Bain to have been collected by himself near Beaufort West. The preservation of the specimen leaves something to be desired, but not-

withstanding defects the skull belongs to a most interesting Anomodont, indicating a new family of fossil Reptilia.

The skull is fully described in the paper, and its relationships are discussed. The Author has already given reasons for regarding *Ælurosaurus felinus*, *Lycosaurus curvimola*, and their allies as referable to a suborder *Gennetotheria*, which is nearly related apparently to the *Pelycosauria*, and lies midway between the typical *Theriodontia* and the *Dicynodontia*. It is to this suborder that *Delphinognathus* may be referred, though it forms a family-type distinct from the *Ælurosauridae*, distinguished by the conical parietal with a large foramen, the anterior supra-condylar notch in the squamosal bone, and other modifications of the skull and teeth.

2. "On Further Evidence of *Endothiodon bathystoma* (Owen) from Oude Kloof, in the Nieuwveldt Mountains, Cape Colony." By Prof. H. G. Seeley, F.R.S., F.G.S.

Two bones found by Mr. T. Bain at Oude Kloof consist of the left ramus of the mandible and what the Author regards as the left squamosal bone of *E. bathystoma*. The small cranial fragment preserved shows that the cerebral region probably conformed to the type of skull seen in some of the *Dicynodonts*.

A description of the remains is given, and the Author notices that the form of the articular condyle indicates a difference from *Dicynodontia* and all other *Anomodontia* hitherto described; it implies an oblique forward inclination of the quadrate bone—a character important in defining the suborder *Endothiodontia*. All the characters of the dentition of the animal suggest near affinity with the *Theriodontia*, especially the long lanceolate teeth strongly serrated.

3. "On the Discovery of Mammoth and other Remains in Endsleigh Street, and on Sections exposed in Endsleigh Gardens, Gordon Street, Gordon Square, and Tavistock Square, N.W." By Henry Hicks, M.D., F.R.S., Secretary of the Geological Society.

In this paper the Author gives a description of the deposits overlying the loam in which the remains of the Mammoth and other animals were found in Endsleigh Street, N.W. Under about 6 feet of made ground there was about 10 feet of a yellowish-brown clay containing flints and much 'race.' Below the clay there was about 5 feet of sand and gravel, and under this about 1 foot of clayey loam, in which most of the bones were embedded. This loam contained many seeds, recognized by Mr. Clement Reid, F.G.S., as being those of plants usually found in marshy places or ponds and having a range at present from the Arctic Circle to the South of Europe. A list of the bones found is given by Mr. E. T. Newton, F.G.S., of the Museum of Practical Geology, Jermyn Street, who describes them as being those of one full-grown

Mammoth, of another about half-grown, of the Red Deer, the fossil Horse, and of a small rodent.

The Author gives sections through Endsleigh Street and along the southern side of Endsleigh Gardens, and shows that where the bones were found there was a distinct valley in the London Clay, running in a direction nearly due north and south, the inclination of the valley being towards the north. The London Clay reached nearest to the surface towards St. Pancras Church and in Upper Woburn Place, the total thickness of the overlying deposits and the made ground there being only about 12 feet.

Other sections, given along the southern sides of Tavistock and Gordon Squares and through Gordon Street and the western side of Gordon Square, show varying thicknesses of the deposits, overlying the uneven floor of London Clay, of from 16 to 21 feet; the greatest thickness here is found at the north-western corner of Gordon Square.

Seeds were also discovered in a loam near the bottom of Gordon Street, at the same horizon as that containing the mammalian remains, and some shells were found in a band of sandy clay, under a calcareous deposit, about halfway down the western side of Gordon Square.

The Author says that the deposits above the mammaliferous loam overlying the London Clay in this area cannot be classed as post-Glacial river-deposits, but must be considered as of Glacial origin. The animals, therefore, which evidently died on the old land-surface where their remains were found, lived there early in the Glacial Period.

4. "The Morphology of *Stephanoceras zigzag*." By S. S. Buckman, Esq., F.G.S.

Material which has come into the Author's possession throws light on the developments of *Stephanoceras zigzag*, and such developments seem to supply missing links in the connexion of Bathonian and Bajocian species.

The Author separates the developments of *S. zigzag* into three series, and discusses the allied forms of each.

MISCELLANEOUS.

On some new Coccidiidæ parasitic in Fishes.

By M. P. THÉLOHAN.

I HAVE already described* as *Coccidium gasterostei* and *C. sardine* two species of the genus *Coccidium*, the entire development of which

* Thélohan, "Sur deux Coccidies nouvelles, parasites de l'Épinoche et de la Sardine," *Comptes Rendus de la Société de Biologie*, June 15, 1890; id. 'Annales de Micrographie,' 1890 (Ann. & Mag. Nat. Hist. 1890, vi. p. 194).

takes place within the tissues of the host; moreover, the enveloping membrane of the cysts of these species is of an extreme delicacy, presenting a contrast with the thickness and resistance of the same envelope in the other species previously described, and in which, as we know, development is partially accomplished in the external medium.

I have since been able to observe similar facts in other species of *Coccidium*, likewise parasitic in fishes, which have, moreover, enabled me to establish certain interesting peculiarities.

I met with one of these parasites in the liver of *Caranx trachurus* (at Concarneau, Saint-Valery-en-Caux). In the adult stato, which alone I was able to observe, it appears in the form of a perfectly spherical cyst, with a mean diameter of $25\ \mu$, and enclosing four spores without a trace of a residual mass. These spores within the cyst are arranged in very regular fashion crosswise and by two and two, in such a way that the two spores which correspond to the same diameter of the cyst are placed at the same level and above or below the two others. I propose the name *Coccidium cruciatum* for this species, to commemorate this arrangement, which is constant and very characteristic.

The spores when seen in optical section present an elliptical or oval contour. They measure on an average 7 to $9\ \mu$ in length by $6\ \mu$ in breadth. Their envelope, which is tolerably thick, is very remarkable on account of its composition; it is, in fact, formed of two apposed valves, and this has not hitherto been observed in any Coccidiid. All round the spore, in the direction of its greater diameter, we observe a kind of little thickening, marking the line of union of the valves.

The contents in the fresh state exhibit nothing but large refringent globules; these elements, which represent a residual mass, or "noyau de reliquat," disappear in greater part under the action of reagents, and we are enabled to detect the falciform bodies. In preparations which are not stained or where the stain is non-elective we often fancy we are able to distinguish four of these: this is due to the fact that these elements, which are longer than the spore, are recurved within its cavity; moreover, at the level of the thickening of the case a phenomenon of refraction is produced, which gives the sensation of a solution of continuity in their length. But in reality there exist but two of these bodies, and by studying preparations properly fixed and stained we come to distinguish them clearly, as well as the nucleus of each.

I have found *C. cruciatum* sometimes disseminated in the tissue of the liver, sometimes in little brownish masses enclosing a variable number of cysts, and situated usually in contact with important vessels.

In the liver of the sardine I have observed another very closely allied Coccidiid. It differs from *C. cruciatum* only in the fact that the dimensions of the cyst are perhaps slightly smaller and that its spores are never arranged in any order. The latter present pre-

cisely the same characters as in the preceding species. I abstain for the moment from giving a name to this parasite, since my observations do not permit me to decide with a sufficient degree of certainty whether it is necessary to distinguish it specifically from the parasite of *Caranx*, or whether the two organisms are to be united under the same name.

Lastly, I have found in the kidney, the spleen, and the liver of the tench a *Coccidium* of very small size, for which I propose the name *C. minutum*. The cyst measures no more than 9 to 10 μ (in sections). I was able to follow the various phases of the development, and, among others, to recognize in this form the karyokinetic division of the nucleus which I had previously reported in *C. gasterosteii*. There are four fusiform spores, each enclosing two nucleate falciform bodies.

In concluding this note I desire to draw attention to some very singular little bodies which I have met with for a long time in the tissues of different fishes.

They are oval in form, occasionally a little irregular, and are provided with a thick envelope with a very sharp double contour. In the interior a nucleus is observed, usually situated at one of the extremities; the remainder of the cavity is filled by a large number of very delicate little rods, which appear to converge towards a point, most frequently lying opposite to the nucleus. Their dimensions seem to vary in the different fishes. I have found them 6 to 9 μ in length by 4 to 6 μ in breadth in the epithelium of the intestine of the perch; 10 to 12 μ by 5 to 8 μ in the kidney of the stickleback; 15 μ by 10 to 12 μ in the connective tissue of the ovary of the minnow; and 12 to 15 μ by 6 to 9 μ in the epithelium of the gills of the tench. I have also found them in the bleak, the carp, &c. My excellent friend, Dr. Laguesse, in the course of his beautiful researches into the histology of fishes, has had occasion to observe the same bodies, especially in *Orenilabrus*.

Unfortunately I can do nothing but state the existence of these singular forms. Their parasitic nature appears to me to be almost beyond doubt; but their characters are so peculiar that I have been unable to discover any affinity between them and the parasites at present known.—*Comptes Rendus hebdomadaires des séances de la Société de Biologie* (Séance du 9 janvier, 1892): from a separate impression communicated by the Author.

On the Dissemination of Hirudinea by the Palmipeds.

By M. JULES DE GUERNE.

MM. Raphaël Blanchard and Mégnin have recently published, in the '*Comptes Rendus des séances de la Société de Biologie*'*, several

* Raphaël Blanchard, "Sur la Sangsue de Cheval du Nord de l'Afrique" (séance du 17 octobre, 1891); P. Mégnin, "Sangsues de l'Algérie et de Tunisie ayant séjourné plus d'un mois dans la bouche de Bœufs et de Chevaux" (séance du 24 octobre, 1891).

remarkable cases of the carriage of living leeches by Mammals. The facts mentioned below will show that the aquatic birds, and especially the migratory Palmipeds, can also become very active agents in the dissemination of Hirudinea.

Being installed in the spring of 1888 in the neighbourhood of a large marsh-shooting in the Department of the Marne*, for the purpose of investigating at that spot various points in the freshwater fauna, my attention was attracted for the first time on the 5th of April by a little leech. It was lying dead (but still fresh and sufficiently well preserved for study) on a stone table upon which the sportsmen were in the habit of depositing their game. That day the bag comprised, as the result of the morning's work alone, some fifteen wild duck, teal, and pintails. From that time I examined all the birds killed, with the special object of discovering leeches. It was only on the 8th of April that a second leech was obtained upon a widgeon (*Mareca penelope*, L.) among the ventral feathers. This soon died. The same day, having deposited upon my work-table a teal (*Querquedula crecca*, L.), shot flying a few moments previously, great was my satisfaction on seeing emerge from the plumage of the anterior part of the breast a worm similar to the foregoing (6 millim. in length).

This specimen, which was very active, was at once isolated, and two days afterwards brought alive to Paris. I was unable to study this Hirudinean, owing to being engaged at the time upon the preparations for the fourth scientific expedition of the 'Hirondelle,' on which I was to accompany the Prince of Monaco. Various efforts which were made to feed it were without result; it never touched the living Batrachians or Mollusks which were offered it. Attached by its posterior sucker, the creature swayed incessantly to and fro with a rhythmic motion or moved about on the walls of the jar with the well-known geometric gait (*démarche géométrique*) of the looper caterpillars †.

At the moment of setting out for the Azores, on the 16th of June, I decided to entrust my little Hirudinean to Prof. Moniez, who has the management of splendidly arranged aquaria at the Laboratory

* Arrondissement de Vitry. In order to give an idea of the importance of this shooting, I will simply mention that the pools there occupy an extent of more than 500 acres (200 hectares). On four of these pools only, shooting is done from a hut, and in good seasons a skilful duck-shot can kill about nine hundred wild duck (*Anas boschas*, L.) there, without speaking of the rest. The number of head killed has sometimes exceeded two thousand.

† It is curious to observe these two peculiarities, because each of them has been the cause of a name actually applied to worms formerly confounded with this:—*Hirudo oscillatoria*, Saint-Amans, 1824, and *Hirudo geometra*, Brightwell, 1842. This, moreover, is what O. F. Müller says of the young:—"Raro quiescunt, Geometrarum instar progrediuntur et quidem festinante gressu" (Verm. terrest. et fluv. . . . hist. vol. i. part 2, p. 45).

of Natural History of the Faculty of Medicine of Lille. Here it lived, always very active and never feeding, until November 6th, 1888.

The thermometer was low on the day when I obtained this leech; it had snowed the night before, and the temperature of the water of the marshes scarcely exceeded 3° or 4° C. This did not prevent it from supporting the heat of the summer in a vessel of limited dimensions, in which it had seemed desirable to leave it in order to avoid losing it. The ability of the animal to resist striking changes of temperature is therefore established, and the feature is worthy of remark when it is a question of dissemination into waters situated at distant latitudes.

The foregoing notes, extracted almost word for word from my note-book of observations, had been taken a long time when I had the opportunity of entrusting the Hirudineans with which we are dealing to Dr. Raphaël Blanchard for the purpose of systematic study. This, as we shall see, furnishes some curious results.

To begin with, the three specimens belong to the same species—*Glossiphonia tessellata*, discovered in Denmark and described by O. F. Müller in 1774. Its geographical distribution, as at present known, extends in Europe from the Arctic Circle, within which it has been found in the Kola Peninsula (Russian Lapland), as far as Budapest. Nevertheless it had not previously been reported in France, and it is sufficiently peculiar that it should be met with there for the first time upon Palmipeds. Dr. Raphaël Blanchard has since obtained, in August 1890, two specimens only of the species in the Erdre, near Nantes.

This form is moreover everywhere regarded as rare, and the naturalists who have observed it most carefully point out a peculiarity in its mode of life which is worthy of mention here. *Gl. tessellata* crawls as it were upside down at the surface of the water in the open spaces, as do the Planarians and certain Mollusks. The animal is thus favourably situated for attaching itself to the migratory Palmipeds, which *pitch* (*tombent*), to use the technical expression, and at times in numerous flocks, on the clear waters of the marshes.

Furthermore, an observation by Dr. Weltner* shows that Palmipeds are readily attacked by *Gl. tessellata*. At a farm in the village of Wanzenu, near Strassburg, a flock of geese and ducks was almost destroyed by this leech. The birds were emaciated and restless and carried a certain number of these worms firmly fixed in the oesophagus. Dr. Weltner believes that the leeches were searched for by the birds as food, and, not having been swallowed sufficiently quickly, had attached themselves in passing down the gullet. I have never met with Hirudineans in the digestive tracts of the numerous aquatic birds which I have examined for the purpose of

* Weltner, "*Clepsine tessellata*, O. F. Müll., aus dem Tegelsee bei Berlin," Sitzungsberichte der Gesellsch. naturforsch. Freunde zu Berlin, 17 mai, 1887.

studying their food. It therefore appears to me to be more in conformity with the truth to suppose that the worms had attached themselves of their own accord to the mucous membranes of the ducks or geese as they were engaged in seeking their food *.

I would add that the call-ducks employed in shooting, which remain attached to cords for hours at a time out in the water in front of the huts, are sometimes attacked by little leeches. The keepers, however, by whom I was informed of the fact, never procured me any specimens.

Be that as it may, the possibility of the dissemination of leeches by Palmipeds appears to be placed absolutely beyond doubt. In damp weather a leech, sheltered beneath the compact plumage of a duck, can be transported a very long distance in a very few hours †, especially if the flight is further accelerated by some atmospheric disturbance. I may be permitted to quote a final instance, which will serve to clear up the subject.

In the only case with which I am acquainted in which a leech (*Lophobdella Quatreforesi*, Poir. & Rocheb.) was reported as having accidentally attached itself to birds, the creature was actually found upon migratory Palmipeds, on the internal wall of the pouch of pelicans (*Pelecanus crispus*, Bruch., and *P. onocrotalus*, L.). From the special point of view of dissemination it is curious to compare this fact with the following, mentioned by Caspari, the hydrographic engineer, and which I tender, without further comment, to all those who are interested in the grand phenomena of Nature:—

“Another less formidable but very curious effect of the tornados is their influence on the fauna of the regions visited by them. That of 1865 acclimatized pelicans in Guadeloupe; these birds, according to the old fishermen, were formerly unknown in the island, and to-day they abound in the whole of the north-west portion, near the Grand Cul-de-Sac” ‡.—*Comptes Rendus hebdomadaires des séances de la Société de Biologie* (Séance du 30 janvier, 1892): from a separate impression communicated by the Author.

* I would mention, as being closely connected with this, a case observed in Ireland, and reported in ‘The Veterinarian,’ ser. 4, vol. viii. Jan. 1862, p. 19 (“Worms in the Eyes of Geese”). I am indebted to Prof. Railliet for bringing it to my notice.

† The case was one of geese being rendered blind by leeches (?). On the eyeball of one of the birds being divided “a small black worm, just like a young leech, came out.” The creature in question was kept alive for some time in a veterinary hospital in Dublin. The affected geese had access to a stream where there were numbers of leeches. It remains to be discovered how the worms were able to penetrate the eye. The species was not determined.

‡ I may here remind the reader that a wild duck flies in ordinary weather at a speed of 40 to 45 miles (66 à 72 kilomètres) an hour. *Vide* J. de Guerne, ‘Excursions zoologiques dans les îles de Fayal et de San Miguel (Açores),’ Paris, 1888, p. 89.

§ Caspari, “Une Mission à la Guadeloupe. Notes de géographie physique” (‘Revue maritime et coloniale,’ Oct. 1871, p. 412).

THE ANNALS

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[SIXTH SERIES.]

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XII.—*On the Shells of the Victoria Nyanza or Lake Oukéréwé.* By EDGAR A. SMITH.

[Plate XII. figs. 3-6, 8-16.]

THE first record of any shells from this great African lake appeared in the 'Proceedings of the Zoological Society' for 1864. In a list of the shells collected by Capt. Speke during his second journey through Central Africa Dr. H. Dohrn quoted the following from the lake, viz.:—1. *Limnæa*, sp.; 2. *Planorbis*, sp.; 3. *Lanistes Boltenianus*; 4. *Paludina* [= *Viviparus*] *unicolor*; 5. *Paludina* [= *Cleopatra*] *bulimoides*.

This collection was presented to the British Museum by Capt. Speke; but the localities attached to the above specimens make it very doubtful if any of them really were obtained from the Victoria Nyanza. Dohrn himself (*l. c.* p. 116) observes that "the specimens from different localities have been partly mixed up."

With the exception of the *Lanistes*, which are marked "from the Kanagwa and Uzandu district," the rest were transmitted to the Museum with the locality "Nile district, between 3° and 14° N. lat." The "gigantic specimen from the lake, more than twice as long as usual," of *Paludina bulimoides* is labelled "Usaramo, E. Africa, Plateau, 6° S.

lat." It is a variety of the *Oleopatra Guillemei* of Bourguignat and perfectly distinct from *bulimoides*, having the upper whorls sharply angled and the base of the body-whorl around the umbilicus encircled with five strong concentric liræ.

Considering, therefore, the doubt attaching to the localities of the specimens in question, it seems to me advisable to exclude these five species from the list of the lake shells until their occurrence there has been further established.

The next mention of shells from the Oukéréwé lake occurs in the 'Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin' for 1879. At p. 105 Dr. E. von Martens enumerated nine species collected by Emmin Effendi in 1877 on the south-west shores, as follows:—1. *Physa*, sp.; 2. *Planorbis choanomyhalus*, sp. n.; 3. *Paludina rubicunda*, sp. n.; 4. *Paludina capillata*, Frfld.; 5. *Bythinia Stanleyi*, Smith; 6. *Melania tuberculata*, var.; 7. *Unio Bakeri*, H. Adams; 8. *U. acuminatus*, H. Ad.; 9. *Corbicula radiata*, Phil.

M. Bourguignat in 1883 (Moll. fluv. du Nyanza Oukéréwé), unaware of the papers by Dohrn and Martens, mentioned the following ten species as the first recorded from this locality:—1. *Melania tuberculata*; 2. *Vivipara abyssinica*; 3. *Mutela subdiaphana*; 4. *Unio Hautteceuri*; 5. *U. Grandidieri*; 6. *U. Duponti*; 7. *U. Ruellani*; 8. *U. Edwardsianus*; 9. *U. Grantianus*; 10. *U. Monceti*.

In 1885 ('Espèces nouv. et gen. nouv. Oukéréwé et Tanganika') he described the following:—*Oleopatra Guillemei*, *Mutela Bourguignati*, and *Spatha Bourguignati*.

Finally in 1887 (Bull. Soc. Malac. France, vol. iv. pp. 267–272) he enumerated the thirteen species known to him from the lake, and described two others, *Limnæa Debaizei* and *Unio Lourdeli*.

I now add to the preceding three new species of *Viviparus*, *Mutela rubens*, Lamk., and *Limosina parasitica* (Parreyss), so that the complete list of the known shells from the lake is here given.

The fauna of the Victoria Nyanza, as far as we know it at present, appears to be quite Nilotic, and no such remarkable forms as occur in Lake Tanganyika have as yet been met with. It does not possess a specialized fauna like that lake, and out of the twenty-eight species hereafter enumerated twelve have been recorded from the Nile or one or other of the great lakes, and of the remaining sixteen so-called species very close representatives occur in other lakes and rivers of Central Africa.

I. GASTROPODA.

1. *Limnæa Debaizei*, Bourguignat.

Limnæa Debaizei, Bourguignat, Bull. Soc. Mal. France, 1887, vol. iv. p. 208.

This species also occurs at Bagamoyo (*Bourg.*). It evidently is very closely allied to *L. natalensis*, Krauss.

2. *Physa*, sp.

Physa, sp., Martens, SB. Gesell. nat. Freund. Berlin, 1879, p. 108.

Hab. South-west shore.

Perhaps *P. nyassana*, Smith (*Martens*).

3. *Planorbis choanomphalus*, Martens.

Planorbis choanomphalus, Martens, l. c. p. 108.

From the south-west shore.

4. *Melania tuberculata*, Müller, var.

Melania tuberculata, Muller, var., Martens, l. c. p. 104; Bourguignat, Moll. fluv. du Nyanza Oukéréwé, 1883, p. 4.

Hab. South and south-west shore.

5. *Viviparus abyssinicus*, Martens.

Vivipara abyssinica, Bourguignat, l. c. 1883, p. 4.

Hab. South end of the lake.

6. *Viviparus rubicundus*, Martens.
(Pl. XII. fig. 3.)

Paludina rubicunda, Martens, l. c. p. 104; Smith, P. Z. S. 1888, p. 53, as *Paludina unicolor*, var.

Hab. South-west shore (*Martens*); Nile region between 3° and 14° N. lat. (*Speke*, in B. M.); Albert Nyanza (*Smith*).

This is a very pretty species, distinguished by its pinkish colour and rounded whorls.

7. *Viviparus capillatus*, Frauenfeld.

Paludina capillata, Martens, l. c. p. 104.

Hab. South shore (*Martens*); Lake Nyassa (*Fryd.*).

Martens only had young specimens under examination, and it seems to me possible that they may be referable to the following species, as he mentions their possessing two distinct keels. *V. capillatus* has an angle at the periphery and a shouldering above, but it cannot be described as carinate.

8. *Viviparus victoriæ*. (Pl. XII. figs. 8-10.)

Paludina, sp. n., Smith, Ann. & Mag. Nat. Hist. August 1890, p. 149.

Testa umbilicata, conica. mediocriter tenuis, epidermido olivacea nitida induta, ad apicem plus minus erosa, purpurea: anfractus 6, convexiusculi, inferne ad suturam carinati, interdum paulo supra medium leviter carinati vel angulati, lineis incrementi obliquis flexuosis, striaeque spiralibus tenuissimis sculpti, ultimus circa medium carinatus, plerumque ad aperturam leviter infra carinam descendens; apertura subcircularis, longit. totius $\frac{2}{3}$ adæquans, intus submargaritacea; perist. ad marginem nigrescens, latere columellari leviter incrassato.

Longit. 33 millim., diam. 20; apertura 14 longa, $12\frac{1}{2}$ lata.

Var. *a*. Testa vix umbilicata, anfractu ultimo fortiter et acute carinato, carina supra spiram pagodiformem continua.

Var. *b*. Testa minor, vix perforata, solidior, carinis fere obsoletis, anfractibus magis rotundatis, epidermide magis strigata.

I have set aside certain specimens as varieties *a* and *b* chiefly to call attention to the great variability of this species. At first sight it seems hardly credible that the var. *b* can belong to the same species as the type. However, the series of specimens in the Museum apparently proves them to be so. The strength of the carination, the size of the umbilicus, and the size of the shells themselves are very variable; but even in specimens which are least keeled traces of the keels are noticeable. The slight angulation near and a little above the middle of the whorls of the spire is more distinct in some specimens than others, and the spiral sculpture is also distinct in some instances, feeble in others.

In the var. *a* the strong keel of the body-whorl revolves up the spire a little above the suture, so that the spire presents a pagodiform appearance. In these specimens also the termination of the keel modifies the form of the aperture, producing a slight angle in the middle of the outer lip.

9. *Viviparus jucundus*. (Pl. XII. fig. 6.)

Testa parva, imperforata, ovato-turrita, haud nitida, epidermide tenni olivacea induta, ad apicem erosa; anfractus 5, convexiusculi, sutura profunda seuncti, lineis incrementi obliquis conspicuis,

aliisque spiralibus tenuibus confertis decussatis sculpti, ultimus in medio angulatus, antice haud descendens; apertura ovato-auriformis, longit. totius $\frac{1}{2}$ adæquans; peristoma tenue, vix continuum, marginibus callo tenuissimo nitente junctis, columellari leviter incrassato, subreflexo.

Longit. 1.4 millim., diam. $9\frac{1}{2}$; apertura 7 longa, $5\frac{1}{2}$ lata.

This species is remarkable for its small size, the dull, spirally and obliquely striated surface, and the peripheral angulation of the body-whorl. It was obtained at the Victoria Nyanza by Bishop Hannington.

This is not the young of *V. victoriae*, but evidently a species which does not attain larger dimensions than those given above. It is distinguished from that species not only by its size but by the more distinct spiral sculpture, the more shouldered whorls, the deeper suture, and the absence of an umbilicus.

10. *Viviparus cepoides*. (Pl. XII. fig. 4.)

Testa anguste umbilicata, ovata, turrata, tenuis, epidermide viride induta, strigis obliquis saturate olivaceis zonisque vel lineis paucis obsoletis picta, parum nitida, interdum limbo rufo obtecta: anfractus 6, convexi, superne humerosi, incrementi lineis obliquis striisque spiralibus plus minus obsoletis sculpti, sutura profunda sejuncti; ultimus rotundatus, ad peripheriam haud angulatus; apertura magna, ovato-rotundata, intus cæruleo-alba, longit. totius $\frac{1}{2}$ adæquans; peristoma tenue, marginibus callo tenui junctis, columellari leviter incrassato, sed vix reflexo.

Longit. 33 millim., diam. maj. $22\frac{1}{2}$; apertura $17\frac{1}{2}$ longa, $13\frac{1}{2}$ lata.

Hab. Either the Victoria Nyanza or from the Nile between 3° and 14° N. lat. (*Capt. Speke*).

This species is comparatively thin and is remarkable for the shouldering of the whorls, the deep suture, the green-striped epidermis, and the large aperture. The spiral striæ, although not strong, are quite apparent, being more conspicuous around the umbilicus than elsewhere.

All the four specimens collected by Capt. Speke were more or less coated with a rust-like deposit. They vary very little, excepting the spire may be somewhat longer in some specimens than others.

11. *Cleopatra Guillemei*, Bourguignat. (Pl. XII. fig. 5.)

Cleopatra Guillemei, Bourguignat, Esp. nouv. et gen. nouv. Oukéréwé et Tanganika, p. 6.

Like *C. bulimoides* (Olivier), but readily distinguished by the grooves around the umbilicus.

12. *Bithynia Stanleyi*, Smith, var. *humerosa*.*Bithynia Stanleyi*, Smith, var. *humerosa*, Martens, l. c. p. 104.*Hab.* South-west shore (M.) ; Lake Nyassa (Smith).

II. PELECYPODA.

13. *Corbicula radiata*, Parreyss.*Hab.* River Nile ; also Lakes Albert, Tanganyika, and Nyassa, Victoria Nyanza (Martens).

I have already quoted this species from the Victoria Nyanza (Ann. & Mag. Nat. Hist., Aug. 1890, p. 149). It was obtained on the south shore of the lake both by Emin Pasha and the late Bishop Hannington. Some of the specimens are without rays, other examples, in addition to the violet rays, exhibit others of a rich brown or reddish colour. The epidermis is variable, being olive-green, greenish yellow, or simply yellow.

14. *Limosina parasitica* (Parreyss).*Hab.* First Cataract at Assouan on the Upper Nile (Parreyss).

This species is considered by Clessin (Conch.-Cab. Monog. Cycladeen, p. 247) synonymous with *L. ferruginea*, Krauss*. On comparing specimens of these forms received from Parreyss and Krauss they appear to differ somewhat both in form and sculpture. *L. parasitica* is slightly longer and narrower and the concentric lines are stronger and more lamellar. The specimens obtained at the Victoria Nyanza by Bishop Hannington are exactly similar to those from Assouan.

15. *Unio Bakeri*, H. Adams. (Pl. XII. fig. 11.)*Unio Bakeri*, Martens, l. c. p. 104.*Hab.* South-west shore (M.) ; Albert Nyanza (Sir Samuel Baker and Emin Pasha).

I have already (P. Z. S. 1888, p. 56) pointed out the similarity between this and some of the following species described by Bourguignat, and it seems very probable that the shells referred to the present species by Dr. E. von

* Besides South Africa I have already quoted this species from Madagascar and Mauritius (P. Z. S. 1882, p. 388).

Martens belong rather to one or other of Bourguignat's species than to this Albert Nyanza form.

16. *Unio acuminatus*, H. Adams. (Pl. XII. fig. 12.)

Unio acuminatus, Martens, l. c. p. 105.

Hab. South-west shore (M.) ; Albert Nyanza (*Baker*).

As suggested by Bourguignat, this species is allied to the *U. Monceti* of that author, and therefore it is not impossible that the shells referred to it by Martens may really belong to *Monceti*, as they come from the same lake.

17. *Unio Hautteccœuri*, Bourguignat.

Unio Hautteccœuri, Bourguignat, 1883, Moll. fluv. Oukéréwé, p. 5, figs. 1-3.

18. *Unio Grandidieri*, Bourguignat.

Unio Grandidieri, Bourguignat, l. c. p. 7, figs. 4-6.

19. *Unio Edwardsianus*, Bourguignat.

Unio Edwardsianus, Bourguignat, l. c. p. 12, figs. 7-9.

20. *Unio Duponti*, Bourguignat.

Unio Duponti, Bourguignat, l. c. p. 8, figs. 10-12.

21. *Unio Grantianus*, Bourguignat.

Unio Grantianus, Bourguignat, l. c. p. 14.

Of the five preceding so-called species it is impossible to suppose that the variation in form and sculpture pointed out by Bourguignat would be at all constant. At all events my experience with regard to the Unionidæ of the great Central-African lakes proves that great variation both in outline and ornamentation is constantly met with in many species. I am therefore inclined to believe that these species of M. Bourguignat are merely variations of one and the same species.

22. *Unio Monceti*, Bourguignat.

Unio Monceti, Bourguignat, l. c. p. 15, figs. 13-15.

23. *Unio Ruellani*, Bourguignat.

Unio Ruellani, Bourguignat, l. c. p. 10, figs. 16-18.

24. *Unio Lourdeli*, Bourguignat.
(Pl. XII. figs. 13-15.)

Unio Lourdeli, Bourguignat, Bull. Soc. Mal. France, 1887, vol. iv. p. 271.

This is an elongate posteriorly rostrate form and quite distinct from the rest of the species from the lake. The shells figured are in the collection of S. I. Da Costa, Esq.

25. *Mutela rubens*, Lamarck.

Mutela rubens, Smith, Ann. & Mag. Nat. Hist., Aug. 1890, p. 149.

There is a single valve from the lake obtained by Emin Pasha and presented by him to the British Museum.

26. *Mutela subdiaphana*, Bourguignat.

Mutela subdiaphana, Bourguignat, Moll. fluv. Oukéréwé, 1883, p. 5; Bull. Soc. Mal. France, 1887, vol. iv. p. 268.

Apparently no description of this species has as yet appeared.

27. *Mutela Bourguignati*, Ancey.
(Pl. XII. fig. 16.)

Mutela Bourguignati, Bourguignat, Espèces nouv. et gen. nouv. Oukéréwé et Tanganika, 1885, p. 8.

Hab. Shores of the lake, near the mouth of the Chimayou (*Bourg.*); also Emin Pasha in Brit. Mus.

28. *Spatha (Spathella) Bourguignati*, Ancey.

Spatha (Spathella) Bourguignati, Bourguignat, l. c. 1885, p. 12.

Hab. South shore of the lake (*Bourguignat and Emin Pasha*).

EXPLANATION OF PLATE XII. (part).

Fig. 3. *Viviparus rubicundus*.

Fig. 4. *Viviparus cepoides*.

Fig. 5. *Cleopatra Guillemei*.

Fig. 6. *Viviparus jucundus*.

Fig. 8. *Viviparus victoriæ* (var. b).

Fig. 9. *Viviparus victoriæ* (typical).

Fig. 10. *Viviparus victoriæ* (var. a).

Fig. 11. *Unio Bakeri*.

Fig. 12. *Unio acuminatus*.

Figs. 13-15. *Unio Lourdeli*.

Fig. 16. *Mutela Bourguignati*.

XIII.—Further Additions to the known Marine Molluscan Fauna of St. Helena. By EDGAR A. SMITH.

[Plate XII. figs. 1, 2, & 7.]

SINCE publishing my report upon the marine shells of St. Helena* a few more species, also obtained by Capt. W. H. Turton, R.E., have been identified; some of these may be regarded as indigenous and others as importations, having been obtained on floating seaweed ("sea-horn") which undoubtedly drifts northward from the Cape †. In addition to these, a number of marine species were also discovered by Captain Turton inland at a considerable elevation. Some observations on this interesting discovery will form the concluding portion of this paper.

I. ADDITIONAL INDIGENOUS SPECIES.

Lamellaria perspicua (Linn.).

Hab. North Sea, Atlantic, at Madeira, the Azores, Mediterranean, Adriatic, Ægean; also Atlantic coast of United States, Port Elizabeth, South Africa, and Japan.

Three small specimens from St. Helena appear to belong to this well-known and widely distributed species.

Trivia candidula, Gaskoin.

Hab. Mexico (*Gaskoin*); coast of Spain, Algeria, Canary Isles, Azores, Madeira, Goree.

I have omitted in the above distribution the locality "Sandwich Islands" quoted by Sowerby in his monograph of the genus *Cypræa* in the 'Thesaurus,' also that of Port Jackson mentioned by Angas in the P. Z. S. 1871, p. 94. In the latter case, at all events, I think there is little doubt of a misidentification of the Port Jackson shells, for a specimen in the British Museum from that locality presented by Mr. Angas and named by him "*T. candidula*, Gaskoin," in my opinion is merely a small example of *T. scabriuscula*, Gray. It has quite the form of that species, has the sculpture between the ribs and the dorsal median impression.

The single specimen from St. Helena is small, only 5 millim. in length, whereas three examples presented to the

* Proc. Zool. Soc. 1890, pp. 247-317.

† L. c. p. 247.

Museum by Mr. Gaskoin are almost 8. This, however, is of little importance, as many of the *Trivicæ* exhibit great variation in the size of the specimens. It has been doubted whether the species described originally from Mexico is really the same as that found in the North Atlantic and which is usually considered to be so. Of the identity of the latter with this species there need be no further doubt, for the shells received from Gaskoin, already referred to, are identical with others in the Museum collected by Mr. MacAndrew at Corunna.

I may add that, although Gaskoin quoted "Mexico" as the locality of his species, the specimens received from him were marked "S. America?"

Jeffreysia atlantica. (Pl. XII. fig. 7.)

Testa minuta, ovato-pyramidalis, anguste perforata, albida, tenuis, diaphana, nitida; anfractus $1\frac{1}{2}$, perconvexi, sutura profunda, leviter obliqua sejuncti; apertura ovato-circularis; peristoma tenue, continuum, margine columellari vix reflexo.

Longit. $1\frac{1}{4}$ millim., diam. $\frac{3}{4}$; apertura $\frac{1}{2}$ longa.

This species is less elongate than *J. diaphana* of Alder, has a more conical spire, and a shorter and more globose body-whorl; the aperture also is more circular.

Tellimya producta. (Pl. XII. fig. 2.)

Testa transversa, inæquilateralis, convexa, irregulariter ovato-triangularis, postice producta, tenuis, diaphana, nitida, lineis incrementi tenuissimis, striisque obsoletis radiantibus sculpta; margo dorsi utrinque declivis, ventralis rectus; latus anticum medio-criter latum, rotundatum, posticum paulo acuminatum; umbones antemediani, prominentes; dentes duo valvæ sinistræ divergentes, subvalidi, v. dextræ inconspicui, marginales.

Longit. $6\frac{1}{2}$ millim., alt. 5, diam. 4.

This species is peculiar on account of its form, the posterior end being produced or subrostrate and the ventral margin straight or even faintly incurved. The hinge-teeth in the left valve are rather distinctly developed and divergent, one on each side beneath the umbo; the right valve is practically edentulous. Below the apex the hinge-line is interrupted by a triangular space, the anterior border of which is somewhat thickened, and the dorsal line behind it is narrowly reflexed upward. The pallial line and the adductor scar are very indistinct.

Tellimya simillima. (Pl. XII. fig. 1.)

Testa *T. bidentatæ* similis, sed umbonibus leviter prominentioribus, magis centralibus, dentibus duobus valvæ sinistræ brevioribus et fortioribus.

Longit. $3\frac{1}{2}$ millim., alt. $2\frac{1}{2}$.

This small species is very thin and fragile, pellucid, and agrees in general aspect with *T. bidentata* of Montagu. It is not, however, quite of the same form, having the beaks a little less anterior in position and a trifle more prominent. The two teeth in the left valve are also less divergent, shorter, and stronger.

Montacuta ferruginosa (Montagu).

Hab. North Sea, Atlantic to the Mediterranean.

The two valves from St. Helena evidently belong to this species, which has not, I believe, been previously recorded from so southern a locality.

Pecten pes-felis, var.

Two small valves of this species are rather flatter than usual. They certainly belong, however, to this well-known Mediterranean species.

II. SPECIES FOUND ON FLOATING TANGLE AND TO BE
REGARDED AS SOUTH AFRICAN.*Rissoa fenestrata*, Krauss.

Hab. Mouth of the Knysna (*Krauss*); Port Elizabeth (*Sowerby*).

Trochus (Gibbula) cicer, Menke.

Hab. Cape of Good Hope (*Philippi*); Simon's Bay (*Gould*); Table Bay (*Krauss*); Port Elizabeth (*Sowerby*).

Phasianella bicarinata, Dunker.

Hab. Cape of Good Hope (*Dkr.*).

The bicarination of this pretty little species is accurately described by Dunker as obsolete. Therefore, judging from specimens in the Museum which I identify with this species, I am inclined to suppose that this angulation is exaggerated in the figure given by Pilsbry in Tryon's 'Manual of Conchology,' vol. x. pl. xxxix. a. fig. 10.

Kellia suborbicularis (Montagu).

Hab. North Sea, Mediterranean, Atlantic, Port Elizabeth, Kerguelen Island.

This species has been recorded from all the above localities, and it is quite probable that *K. rotunda*, Deshayes, an Australian species, is not specifically separable from it.

Thecalia concamerata (Bruguère).

Hab. South Africa and South Australia.

Only a few small valves of this species were obtained by Capt. Turton.

Orenella rhombea (Berkeley).

Hab. English coast, North Atlantic, Mediterranean.

This species having been got at St. Helena on "sea-horn," the term locally applied to this kind of floating seaweed, it doubtless also occurs at the Cape, although it has not at present been recorded from there.

III. MARINE SPECIES FOUND INLAND.

The discovery of a considerable number of marine shells at an elevation of about 700 feet is an interesting fact, as nothing of this kind had been observed previously in the island. Capt. Turton, who found them in small patches of sand which had accumulated in certain spots in the bed of a small dried-up watercourse on Sugarloaf Ridge, was at a loss to account for their occurrence in that locality. Mr. R. B. Newton, to whom I mentioned the subject, suggested that probably wind was the agency by which they had been carried up the hillside. This seems a very likely solution, for without exception all the shells are very minute and might easily be blown any distance by hurricanes or whirlwinds. Capt. Turton found these accumulations of sand at intervals, and it would appear that, when storms rushed up the slope, the sand was stopped here and there by projecting rock and accumulated accordingly. He informs me that "the largest patch of sand did not exceed a very few cubic yards, but of course the rains had washed all the rest away." Such accumulations are known to geologists as *Æolian* or *Eluvium* deposits. This is not an instance of a raised beach, as the surroundings generally testify; besides, if such were the case, we should expect to meet with larger marine objects

than the minute forms obtained by Capt. Turton. It will be noticed in the following list that in cases where the species attain in the adult state any size whatever (e. g. the *Natica*, the *Nassa*, the *Littorina*, the *Hipponyx*, the *Gadinia*, and the two *Arcas*) only extremely young specimens occurred. About ten or a dozen other species were obtained, but they are either too fragmentary or in too bad condition for determination. Like those which have been identified they evidently belong to the existing fauna. The descriptions or references of the thirty-three species enumerated may be found in the Proc. Zool. Soc. 1890, pp. 255-305.

With one or two exceptions all traces of colour have left the shells, but the well-preserved condition of many of them would appear to indicate that they had not been buried or exposed to weathering for any very long period.

Besides the shells, two valves of a species of *Lepas* allied to *L. anserifera*, Linn., were found by Capt. Turton inland at another part of the island. These, being very thin and light, might also have been carried there by the wind or by birds; and it is possible that to the latter agency the presence is accountable of "what appeared to be a lava internal cast of a bivalve shell, about 6 inches in length," found by Mr. Melliss* at the summit of High Knoll at an elevation above the sea of 1900 feet.

1. *Columbella* (*Mitrella*) *sanctæ-helenæ*, Smith.

Three small specimens are probably the young of this species.

2. *Pleurotoma* (*Clavus*) *prolongata*, Smith.

A few immature specimens.

3. *Pleurotoma* (*Cluthurella*?) *usta*, Smith.

The specimens which apparently belong to this species have a few denticles within the outer lip. In the type the labrum has the appearance of not being quite fully developed, which might account for the absence of the tubercles.

4. *Nassa sanctæ-helenæ*, A. Adams.

Several young specimens only.

* 'St. Helena,' by J. C. Melliss (1875), p. 61.

5. *Marginella (Volvaria) consanguinea*, Smith.

Possibly some of these specimens may be small examples of *M. cinerea*, Jousseau.

6. *Mitra (Pusia) sanctæ-helenæ*, Smith.

A few specimens, all young and much worn.

7. *Natica Dillwynii*, Payraudeau.

Several specimens, all quite young.

8. *Eulima atlantica*, Smith?

A number of very small examples may possibly belong to this species.

9. *Scalaria sanctæ-helenæ*, Smith.

One immature specimen with the fine riblets worn away apparently belongs to this species.

10. *Turbonilla assimilans*, Smith?

None of the specimens are in sufficiently good condition for certain identification.

11. *Cingulina circinata*, A. Adams.

Two young specimens.

12. *Aclis angulata*, Smith?

Two specimens are probably worn examples of this species.

13. *Leucotina minuta*, Smith.

A single specimen only.

14. *Triforis recta*, Smith.

A few worn broken specimens having the slender form of this species.

15. *Littorina miliaris*, Quoy & Gaimard.

Very small specimens, not more than 2 millim. in length.

16. *Rissoina congenita*, Smith.

Two specimens.

17. *Rissoina Mellissi*, Smith.

A few worn examples.

18. *Rissoina Turtoni*, Smith.

Numerous specimens.

19. *Rissoa ephamilla*, Smith.

Several specimens, none with perfect outer lip.

20. *Rissoa glypta*, Smith.

21. *Rissoa eritima*, Smith.

22. *Rissoa compsa*, Smith.

Numerous specimens, having a very solid look.

23. *Rissoa Wallichi*, Smith.

24. *Rissoa perfecta*, Smith.

25. *Rissoa varicifera*, Smith.

26. *Hipponyx Grayanus*, Menke.

One small specimen, 3 millim. in length.

27. *Turbo (Leptothyra) rubricinctus*, Mighels.

Many specimens.

28. *Liotia arenula*, Smith.

29. *Gadinia costata* (Krauss) ?

One very small specimen, only 4 millim. in length.

30. *Williamia Gussoni* (Costa).

A single specimen, 3 millim. long.

31. *Ervilia subcancellata*, Smith.

32. *Arca (Acar) domingensis*, Lamarck.

Minute specimens only.

33. *Arca sanctæ-helenæ*, Smith.

Only very small examples, not more than 3 millim. long.

EXPLANATION OF PLATE XII. (part).

Fig. 1. *Tellimya similima*.

Fig. 2. *Tellimya producta*.

Fig. 7. *Jeffreysia atlantica*.

XIV.—*Further Notes on the Oviparity of the larger Victorian Peripatus, generally known as P. Leuckartii.* By ARTHUR DENDY, D.Sc.

My observations * on the oviparous habit of the larger Victorian *Peripatus* (hitherto generally regarded as identical with the *Peripatus Leuckartii* of Sängér) have excited a good deal of hostile criticism, chiefly emanating from the pen of Mr. J. J. Fletcher. On three different occasions since the publication of my notes Mr. Fletcher has brought the question before the Linnean Society of New South Wales, and his remarks have been published (I do not know whether in full or not) in the Abstracts of the Proceedings of the Society †.

I have already replied to the earlier criticisms in a short paper read at the Hobart meeting of the Australasian Association for the Advancement of Science, which will, I am informed, be published shortly. Mr. Fletcher's latest observations, however, compel me to return to the question, and I am the more willing to do so as I have some further information to communicate in support of my views.

The object of Mr. Fletcher's latest contribution to the literature of the subject is explained in the opening paragraph, which runs as follows:—"This paper is a reply to certain views expressed by Dr. Dendy with regard to the reproduction of the New South Wales *Peripatus*, which on the *ipse dixit* of Dr. Dendy himself is *P. Leuckartii*, Säng.; the questions at issue being not whether or no the Victorian *Peripatus* is oviparous, but whether, firstly, Dr. Dendy was justified, on the evidence before him and in the absence of any personal knowledge of the reproduction of the New South Wales *Peripatus*, in contradicting statements which were quite in order; and secondly, as Dr. Dendy's views were published in September 1891, and as certain information on the subject was subsequently brought under his notice, whether it is not now nearly time that Dr. Dendy took steps to explain that his views apply wholly and solely to the Victorian *Peripatus*, and to withdraw his insinuations respecting, and his erroneous interpretation of, 'Mr. Fletcher's observations,' because already Dr. Dendy's statements are

* Proc. Roy. Soc. Victoria for 1891, p. 31; 'Nature,' September 17, 1891; and 'Zoologischer Anzeiger,' no. 380 (1891).

† September 30, 1891; February 24, 1892; April 27, 1892.

finding their way into the records of zoological literature, and confusion and misapprehension may result therefrom."

In reply to Mr. Fletcher's indictment I wish to make the following remarks:—

(1) I do not understand the meaning of the statement that the New South Wales *Peripatus* is, "on the *ipse dixit* of Dr. Dendy himself," *P. Leuckartii*. I certainly am not responsible for this identification, which was, I believe, first made by Mr. Olliff, who remarks*, on first recording the animal from New South Wales, that "the species is identical with that recently recorded by Mr. Fletcher from Gippsland, and is probably the *Peripatus Leuckartii* of Sanger." I need scarcely point out that the name *Leuckartii* has since been applied by Mr. Fletcher himself to the New South Wales species.

Possibly Mr. Fletcher means to refer to the larger Victorian species, of which the first recorded specimen was identified by himself† as "in all probability an example of *P. Leuckartii*, Sanger." If Mr. Fletcher will refer to my earliest communication on the subject‡, he will find that in recording the discovery of two specimens at Warburton (only one specimen having been previously recorded from this colony) I made the following statement, "after carefully studying Professor Sedgwick's full description of *P. Leuckartii*, I am fairly certain that they do not belong to that species, but to a new one, which I for the present refrain from naming," basing my conclusion on the remarkable pattern of the skin. Professor Sedgwick, however, in reply to my observations, expressed the opinion§ that the species probably was subject to a considerable range of variation in colour. Having studied more specimens I myself came to the same conclusion||, and have since then followed Mr. Fletcher in calling the larger Victorian species *P. Leuckartii*. This use of the name *Leuckartii* on my part seems to be Mr. Fletcher's chief grievance against me; but I would ask him to remember that I have only followed his own lead in this respect.

(2) I am not aware that I have contradicted any statements, for the simple reason that I cannot find that there were

* Proc. Linn. Soc. N. S. W. vol. ii. p. 931.

† *Ibid.* p. 450.

‡ 'Victorian Naturalist,' January 1889.

§ 'Nature,' February 28, 1889.

|| "Observations on the Australian Species of *Peripatus*," Proc. Roy. Soc. Victoria, July 11, 1889.

any definite statements as to the mode of reproduction of the New South Wales *Peripatus* for me to contradict. There was merely the assumption by Mr. Fletcher (which I quoted and characterized as very natural) that the young animals which he found in company with the parent had been born alive.

(3) I consider that I was fully justified in assuming that the mode of reproduction of the New South Wales *Peripatus* was the same as that of the Victorian one, as at the time when I wrote there were no definite observations published as to the mode of reproduction of the former, and it was almost inconceivable that different individuals which Mr. Fletcher himself, in common with all other writers on the subject, regarded as belonging to one and the same species, should be oviparous in the one colony and viviparous in the other. I have no doubt now that the New South Wales *Peripatus* is viviparous, as maintained by Mr. Fletcher and Professor Haswell; but I would ask Mr. Fletcher to remember that when I wrote the only published observations as to the mode of reproduction of the New South Wales species were (a) the finding of the young in company with the mother, though there was nothing, so far as the published account goes, to show that they had not been hatched from eggs laid for some time: and (b) a footnote* to one of Mr. Fletcher's observations, stating that a female had been dissected and found to be pregnant; the term pregnant is not defined, and might, in my opinion, be correctly applied to a female containing large but undeveloped eggs in the uterus; nothing is said by Mr. Fletcher about the embryos.

Mr. Fletcher may personally have had abundant evidence that the New South Wales *Peripatus* was viviparous, but that evidence was not published and not known to me when I wrote; and therefore I consider that I was quite justified in stating that the mode of reproduction of *P. Leuckartii* was unknown and in placing my own interpretation upon the only recorded facts as to the life-history of the New South Wales form. Naturally I interpreted them in the light of my own observations on the Victorian species. That interpretation I now fully admit to be incorrect, and I congratulate myself that if my observations have had no other good result they have at least elicited some definite information as to the mode of reproduction of the New South Wales *Peripatus*.

(4) Mr. Fletcher seems to be very greatly troubled because

* Proc. Linn. Soc. N. S. W. vol. iii, p. 892.

my statements are already "finding their way into the records of zoological literature, and confusion and misapprehension may result therefrom." There is not the slightest need for confusion now that we have at length a definite statement as to the reproduction of the New South Wales species. It must be perfectly obvious to every reader that my own observations were based entirely on Victorian specimens, as stated distinctly in the paper, and that my suggestion as to the New South Wales form was a perfectly justifiable, though, as it turns out, incorrect deduction from the only published facts. It is perhaps unfortunate that both the New South Wales and Victorian forms should have been included under the name *Leuckartii*, but for this Mr. Fletcher himself is at least as much responsible as any one.

(5) Mr. Fletcher states that the question at issue is not whether or no the Victorian species is oviparous. Herein I must beg to differ from him, as this is the real question which I have been all along trying to solve and compared with which the mere question of nomenclature is, in my opinion, insignificant. In concluding his observations he also indulges in certain offensive and unjustifiable personalities, which I need not quote. It is greatly to be regretted that he should have considered such a proceeding advisable, and, for my own part, I entirely fail to see the advantage to be derived therefrom, and must refuse to follow his example in this respect.

Probably the solution of the whole difficulty will be found to lie in the fact that my original opinion was correct after all and that our larger Victorian *Peripatus* is specifically distinct from *P. Leuckartii*. For the present, however, I still refrain from giving it a distinctive name, as I have had very few specimens from other localities to compare it with, and do not wish, if it can be helped, to create a new species merely on account of the oviparous habit. This question, however, is discussed in my communication to the Australasian Association already referred to.

As to the oviparous habit of our larger Victorian species (so called to distinguish it from the smaller *P. insignis*) I have some additional evidence to offer, and I would like at the same time to recapitulate the main arguments in favour of my view. My critics have entirely ignored all that is new in my observations, such as the remarkable sculptured egg-shell, and have suggested that what I have observed is simply a case of abnormal extrusion of eggs such as takes place sometimes in *P. novæ-zealandiæ*. Professor Hutton, however, who made the observation on the New Zealand species, merely states that the eggs are often extruded before

development is complete, and then always die. Professor Sedgwick quotes these statements in his monograph of the genus, and yet in replying* to my letter in 'Nature' he states that "no one knows whether the eggs so extruded undergo complete development." I suppose that most animals sometimes extrude eggs which never complete their development, but this has really little to do with the question. What I have been endeavouring to prove is that the larger Victorian species of *Peripatus* is normally oviparous. The two principal arguments originally brought forward—both of which have been entirely overlooked by my critics—were (1) that female specimens dissected at various times of the year were never found with embryos in the uterus, as has been so frequently described for other species, but generally with large undeveloped eggs of definite oval shape and with a thick membrane; (2) that the shell or membrane of the eggs after (but not before) being laid is very definitely and characteristically sculptured on the outer surface, in such a manner as to recall the eggs of many insects. This sculpturing alone appears to me to indicate a truly oviparous habit, and, inasmuch as it affords another character common to *Peripatus* and the Insecta, to deserve special attention. I am not aware that a sculptured egg-shell has hitherto been observed in *Peripatus*, and I should be glad to learn from Mr. Fletcher whether anything of the kind has ever been found around embryos of the New South Wales species which have, as he informs us†, been extruded in the process of drowning.

The additional evidence on the subject which I now wish to bring forward consists in the subsequent history of the fourteen eggs which were laid in my vivarium between the 18th May and the 31st July last year, and of one which, though possibly laid about the same time, was not discovered until September 16. Before going any further, however, I may premise that the fact that the eggs are really those of *Peripatus* has been absolutely proved by their development. It may also be as well to relate the fate of the parent animals by which the eggs were laid.

It may be remembered that on the 31st July, 1891, when the eggs were first found, there were in the vivarium three females and one male, all apparently in good health. The male specimen died shortly afterwards, but on August 17th the females were still all alive and apparently healthy. On

* 'Nature,' September 24, 1891.

† Proc. Linn. Soc. N. S. W., September 30, 1891.

August 31st, as mentioned in a postscript to my first communication on the subject, one of the female specimens was found dead. On being dissected the reproductive organs appeared very well developed; but, although the ovary and oviducts were both large (the former containing a great many ovarian eggs), there was not a single egg in either of the oviducts, all having been doubtless laid.

On September 16 the two remaining females were still alive. I killed and dissected one. The organs appeared healthy and well developed. In the lower part of each oviduct one large egg was found. The eggs presented the usual characters, having a very thick but unsculptured envelope filled with yolk. Both eggs were cut open and examined microscopically, but I did not succeed in recognizing any trace of an embryo in either.

On completely turning out the vivarium and examining its contents carefully I found one more *Peripatus* egg amongst the rotten wood (September 16). It looked much healthier than those which had previously been transferred from the vivarium, many of the latter having already begun to shrivel up and acquire a dark colour. In the newly found egg, and also in the healthier looking of those previously obtained, there now appeared to be a dark spot in the interior, but this was only dimly visible through the thick, sculptured shell.

On September 25th the last remaining female was still apparently in good health, but on October 1st it was found dead—how long it had been so I do not know. On dissection I found the internal organs in a bad condition. Neither eggs nor embryo were visible in the oviducts. The ducts of the slime-glands were very much enlarged and swollen out, while the branched portions appeared feebly developed, in fact not distinctly recognizable. The alimentary canal was almost empty and the animal seemed to have died of starvation.

On October 3rd I dissected one of the eggs from the hatching-box. I could find no embryo in it, but only the same semi-liquid yolk-like contents as when *in utero*, full of little oil- or yolk-globules. Inside the thick, sculptured "shell" there was, as usual, a very thin and delicate transparent membrane. Probably a young embryo was really present, but was broken up in opening the egg and overlooked; even at a much later period the embryonic tissues are extremely delicate.

On November 30 I noted that several of the eggs were showing indications of an embryo appearing coiled up within them, but the shell was so thick and opaque that it was

impossible to make out any details. I dissected the egg which was found on September 16 and which had since then been kept separate from the rest. I found in it a beautiful embryo *Peripatus* in an advanced stage of development. The embryo was surrounded by a delicate transparent membrane, which fitted closely on to it and was very difficult to remove; outside this came the sculptured shell. The embryo possessed a distinct head, with clearly recognizable brain, eyes, and ringed antennæ, and there were at least seven pairs of appendages behind the antennæ. It lay tightly coiled up, with the posterior extremity resting against the side of the neck, in such a position as to make it very difficult to count the appendages. The specimen was stained and mounted in Canada balsam.

This embryo, then, developed for more than ten weeks after the egg had been laid, and did not show the least sign of "going to the bad."

I need hardly say that during the heat of the summer months I found it a very difficult matter to keep the eggs in a suitable condition of moisture, especially as I had no previous experience to guide me. Hence it is not to be wondered at that the majority of the eggs perished, shrivelling up and being attacked by a mould. As I was away from Melbourne for some weeks during the summer I entrusted the eggs to the care of the Rev. W. Fielder, who most kindly looked after them for me in my absence. Frequent attention was necessary in renewing the supply of moisture.

On April 14th, 1892, only three eggs remained in the hatching-box, the others having been removed as they showed signs of going bad. One of the remaining three had been showing dark pigment inside for some days past. This egg I removed and carefully dissected. I found the shell of a much darker (yellow) colour than when laid, a good deal crumpled on the surface, and very soft, as though beginning to decay away. The contained embryo was removed and found to be in excellent condition, although *outside* it there appeared under the microscope a great many very fine threads, which I take to be the hyphæ of a fungus. Possibly this fungus might have ultimately killed the embryo, but the latter was so far advanced that it seemed to be on the verge of hatching. It was enclosed within the usual transparent delicate membrane lying within the thick shell. I could not determine whether the fungal hyphæ had penetrated within this inner membrane, but I think it very doubtful. The embryo was tightly coiled up as in the previous case. When uncoiled it measured about 5 millim. in length (exclusive of

the antennæ) and 1 millim. in breadth. *All* the appendages were developed, viz. antennæ, oral papillæ, two pairs of jaws, and fifteen pairs of claw-bearing legs. The eyes were conspicuous at the bases of the antennæ, and the antennæ themselves showed each about twenty deeply pigmented annuli. The remainder of the body was nearly white; but very distinct isolated pigment patches (chiefly indigo-blue, with a few specks of orange) appeared, scattered pretty abundantly over the legs and back. The mouth was surrounded by the very characteristic thick transversely furrowed lip. The dermal papillæ were very obvious and exhibited the characteristic spines, the cuticle being very strongly developed. The claws on the feet were very distinct. The alimentary canal was full of granular food-yolk. The specimen was stained with borax carmine and mounted in Canada balsam.

This embryo, then, developed for at least eight months and a half after the egg was laid, and at the end of that time was a perfect young *Peripatus*, differing externally from the adult only in its smaller size and less deeply pigmented skin.

There are still two eggs left in the hatching-box, but they do not look to me at present as if they were going to hatch. Whether they do so or not, however, I think I may fairly claim to have now definitely proved that the larger Victorian *Peripatus* at any rate sometimes lays eggs, and that these eggs are capable of undergoing development outside the body until perfect young animals are produced. The great length of time required for the development of the eggs is very remarkable, but is only what one might expect on considering the unusual length of time required for intra-uterine development in other species.

XV.—On *British Mysidæ*, a Family of Crustacea Schizopoda. By the Rev. Canon A. M. NORMAN, M.A., D.C.L., F.R.S., &c.

[Plates IX. & X.]

IN the 'Annals' for June I published a paper on the British species of the families Lophogastridæ and Euphausiidæ; it is my present purpose to complete the account of our Schizopoda by the following descriptions of the Mysidæ.

Only six species of this family were described in Bell's 'British Stalk-eyed Crustacea.' Since the publication of that work a considerable number of additional species have from time to time been recorded or described. The present paper will be found to contain thirty-three forms, the known geographical distribution of which will be seen in the following table :—

[illegible]

Professor G. O. Sars has recorded forty-five species of Schizopoda from Norway (including Finmark). Of these the following have not yet been found in our seas:—

1. *Euphausia pellucida*, Dana. Oceanic.
2. *Doreomysis arctica*, Kröyer. 200–400 fath.
3. — *tridens*, G. O. Sars. 200–400 fath.
4. — *megalops*, G. O. Sars. 80–200 fath.
5. *Erythrops microphthalma*, G. O. Sars. 100–500 fath.
6. — *abyssorum*, G. O. Sars. 150–230 fath.
7. *Pseudomma roseum*, G. O. Sars. 200–300 fath.
8. — *affine*, G. O. Sars. 200 fath.
9. — *truncatum*, Smith. 150 fath.
10. *Parerythrops obesa*, G. O. Sars. 80–300 fath.
11. — *abyssicola*, G. O. Sars. 100–300 fath.
12. — *robusta*, Smith. 60–150 fath.
13. *Amblyops abbreviata*, G. O. Sars. 150–300 fath.
14. *Mysideis insignis*, G. O. Sars. 100–300 fath.
15. — *grandis*, Goës. 30–100 fath.
16. *Hemimysis abyssicola*, G. O. Sars. 150–300 fath.
17. *Mysidella typica*, G. O. Sars. 50–150 fath.
18. — *typhlops*, G. O. Sars. 150–200 fath.
19. *Mysis oculata*, Fabr.
20. — *mixta*, Lilljeborg.

It will be observed that with the exception of the last two species, which are arctic forms not likely to occur in our seas, all the species in the preceding list are deep-water species, which may be found when the deep-water fauna to the west of our islands shall have been properly investigated.

Sars's work on the Mediterranean Mysidæ contains twenty-one species, and of these fifteen are here recorded as British, together with one not in Sars's list—*Hemimysis lamorneæ*. That such a percentage of Mediterranean forms should also be known in our northern seas is quite at variance with the distribution of other orders of the Crustacea, or, indeed, of any class of the Invertebrata. The wider range of the Schizopoda is probably due to their more active and swimming habits. Thus likewise from the north vast shoals of Euphausiidæ appear to come southwards and make their appearance in the winter months on our eastern coast—and probably on our western also, though as yet they have only been observed off our eastern shores.

Fam. *Mysidæ*.

Maxillipeds stoutly built; exopodite natatory, multiarticulate; epipodite lanceolate and projected into the branchial cavity. *First limbs* of the trunk (here called the gnathopods) are generally like in the general aspect of the endopodite to the maxillipeds*, and differ totally from the following six pairs of *legs*, which are all developed and have their distal portion (here called tarsus, in most cases divided into numerous setiferous articulations. Nail generally feeble or absent, more rarely well developed. No true *branchie* present. *Marsupial pouch* composed of two or three (in *Boreomysis* of seven) pairs of leaf-like processes springing from the bases of the posterior legs. *Pleopods* in female small and rudimentary, in male much more developed†; sometimes in that sex all except the first are biramose and all multiarticulate and natatory; in other genera they are variously modified and the third or fourth pair, or both these pairs, are specially developed to subserve sexual functions. *Inner uropods* with acoustic organ at their base. *No phosphorescent organs*. *Telson* very variable in form, but never as in the Euphausiidæ.

Synopsis of Subfamilies.

- A. *Outer uropods* two-jointed, outer margin of the first joint spined. Telson entire. Tarsus of legs with only one or two joints. with a two-jointed nail *Cynthiliinæ*.
- B. *Outer uropods* one-jointed, their outer margin spined. Telson entire. Tarsus of legs multiarticulate *Gastrosaccinæ*.
- C. *Outer uropods* one-jointed, their outer margin setose.
 - 1. *Gnathopods* conforming in general character of endopodite to the maxilliped.
 - 2. *Gnathopods* conforming in general character to the first legs.
- 1.—a. First legs greatly developed, very strong, and much larger than the following, their tarsus

* In *Mysidella* the gnathopods are quite different from the maxillipeds and very like the first leg.

† But in the genera *Heteromysis* and *Mysidella* the pleopods of the two sexes are of similar character.

two-jointed—first joint very large, spined, second minute; nail strong. Tarsus of remaining five feet multiarticulate. Antennal scale ovate, shorter than peduncle of antennæ. Pleopods simple in both sexes . . *Heteromysinae*.

b. First legs not unlike the following in general character. Male with all the pleopods greatly developed and adapted for swimming, second to fifth pairs biramous, all branches multiarticulate and setose, the outer branch of fourth and sometimes also of third modified for sexual purposes, but the modification only extending to a slight lengthening of the limb and a change in the character of the setæ of the terminal joints *Leptomysinae*.

c. First legs not unlike the following in general character. Male with first, second, and fifth* pleopods as in female; third consisting of a basal joint and two short branches†; fourth of basal joint and two branches, inner minute, outer styliiform and generally of great length. *Mysinae*.

d. First legs not unlike the following in general character. Male with first, second, and fifth pleopods as in female, third and fourth with a basal joint and two branches, the inner minute, one-jointed, the outer in both pairs styliiform, but longer in fourth than in third. . . *Stilomysinae* (not British).
Genus *Stilomysis*, gen. nov.:
type *Mysis grandis*. Goës, = *Mysideis grandis*, G. O. Sars.

2. Pleopods of male all rudimentary, as in female. Maxillipeds strongly built, differing widely in character from those of other Mysidæ: last joint without setæ, terminating in a very long spine and three or more shorter spines. Gnathopods resembling in general character the following legs. *Mysidellinae* (not British).
Genus *Mysidella*, G. O. Sars ‡.

* *Hemimysis* is an exception; in it the fifth pleopods are greatly developed into swimming-organs, and consist of a large basal joint and two multiarticulate strongly setose branches.

† But *Neomysis* and *Diamysis*, Czerniavsky (type *Mysis bahirensis*, G. O. Sars), have third pleopod simple, as in female.

‡ I have brought *Stilomysis* and *Mysidella* into this table, because those genera may occur in our seas.

Subfam. I. *CYNTHILIINÆ*.

Genus 1. *CYNTHILIA*, J. E. Gray, 1850 *.

= *Cynthia*, J. V. Thompson (non Fabr., nec Sav., nec Latr.).

= *Siriella*, Dana, 1852.

Rostrum produced, pointed, sometimes of great size. *Antennal scale* more or less subrhomboidal, outer margin naked, terminating in a spine. *Legs* having the tarsus only two-jointed and terminating in a well-developed two-jointed acute nail, encircled at the base with setæ. *Telson* linguiform or lanceolate, apex entire, sides furnished with spines of unequal length. Outer uropods two-jointed, first joint spined (not setose) on outer margin. *Male* with pleopods having multi-articulate swimming-branches, the inner branch furnished usually with a bifid process, which is usually on the middle pairs curiously involutely coiled.

This genus is at once distinguished from all others by the character of the peræopods and outer uropods.

1. *Cynthia norvegica* (G. O. Sars).

1869. *Siriella norvegica*, G. O. Sars, Undersøgelser over Christiania-fjordens Dybvandsfauna. p. 40.

1870. *Siriella norvegica*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 24, pls. xvii., xviii.

1886. *Siriella norvegica*, Norman, Fourth Annual Report Fishery Board of Scotland, p. 161: Ann. & Mag. Nat. Hist. ser. 5, 1887, vol. xix. p. 96.

Body very slender; cephalothorax hardly broader than pleon. *Rostrum* acutely produced, reaching nearly the middle of first joint of antennules. *Eyes* clavate, of moderate size. *Antennules* having the peduncle much elongated, equalling half the length of the cephalothorax; the first joint a little longer than combined lengths of the two following; third joint longer than the second in female, with three plumose setæ on the inner margin and two or three more at the extremity. *Antennal scale* rhomboidal, scarcely equalling the length of peduncle of antennules, two and a half times as long as broad, very obliquely truncate at the apex, the extremity reaching far beyond the spine of the outer margin. *Legs* rather slender; tarsus and preceding joint equal in length. *Telson* equal in length to one third of the pleon, narrowly lanceolate, constricted near the base, its termination with a strong spine at each corner, and between these three small spines, of which

* J. E. Gray, Cat. Brit. Anim. in Coll. Brit. Mus., Pt. iv. Crustacea, p. 46.

the central is the larger, and two little cilia (or the central portion, as described by Sars, has a "lamina minuta tridentata, deute mediano longiore"), lateral margins densely spined; three or four equal spines on the portion anterior to the constriction, after which smaller spines occupy the spaces between larger ones, towards the extremity every fourth or fifth or sixth spine being larger. *Inner uropods* rather longer than the telson, margined beneath the setæ with a dense row of unequal-sized spines, the terminal two or three also being larger than the rest. *Outer uropods* slightly longer than the inner and nearly twice as broad; second joint nearly twice as long as broad, outer margin of first joint in adult with about sixteen to twenty-three spines. *Length* 20 millim.

Pleopods in male well developed and basal processes of middle pairs completely coiled.

Hab. Near May Island, Firth of Forth, 1889, and Moray Firth, 1891 (*T. Scott*); Port Erin, Isle of Man (*A. Walker*): *Mus. Nor.*

Distribution. Hardanger Fiord, Norway (*A. M. N.*); West Norway (*G. O. Sars*); off Gibraltar, in lat. $38^{\circ} 15' N.$, long. $5^{\circ} 49' W.$, from Zool. Stat. Naples: *Mus. Nor.* Christiania Fiord (*G. O. Sars*).

2. *Cynthilia Clausii* (*G. O. Sars*).

1874. *Siriella Clausii*, *G. O. Sars*. Nye Bidrag til Kunds. om Middelhavets Invertebratfauna, I. Middelhavets Mysider, p. 61, pls. xxix., xxxi.

1882. *Siriella (Siriellides) Clausii*, Czerniavsky, Monographia Mysidarum imprimis Imperii Rossici, fasc. i. p. 105, fasc. iii. p. 33.

1886. *Siriella Clausii*, Norman, Fourth Report Fishery Board of Scotland, p. 100; Ann. & Mag. Nat. Hist. ser. 5, 1887, vol. xix. p. 96.

Very like *S. norvegica*, but a smaller species. *Antennules* with only one plumose seta on inner margin of third joint besides those at the extremity. *Antennal scale* more than three times as long as wide, narrowly subrhomboidal, nearly reaching extremity of peduncle of antennule. *Telson* having three subequal small spines and two cilia between the large spines at the angles of the extremity; not more than two to three smaller spines usually occupy interspaces of larger spines on lateral margins. *Outer uropods* with the terminal joint shorter, about one third longer than broad; outer margin of first joint with ten to fourteen spines. *Length* about 10 millim.

Male with the basal appendage of three middle pairs of pleopods completely coiled.

Lab. Tarbert, Loch Fyne, 1886 (*T. Scott*): *Mus. Nor.*

Distribution. Naples, 1887 (*A. M. N.*); Adriatic (*Prof. Claus and Vienna Museum*): *Mus. Nor.* Goletta, Cagliari, Syracuse, Messina, and Spezzia (*G. O. Sars*).

3. *Cynthilia jaltensis* (Czerniavsky).

1865. *Siriella jaltensis*, Czerniavsky, *Materialia ad Zoographiam Ponticam comparatam*, p. 66, pl. iv. figs. 12, 13.

1870. *Siriella crassipes*, G. O. Sars, *Middel. Mysider*, p. 89, pl. xxxii.

1882. *Siriella (Siriellides) crassipes*, Czerniavsky, *l. c.* fasc. i. p. 105, fasc. iii. p. 32.

1882. *Siriella (Protosiriella) jaltensis*, id. *ibid.* fasc. i. pp. 109, 110. pls. v., vi. fasc. iii. p. 27.

1886. *Siriella crassipes*, Norman, *Fourth Annual Report Fishery Board of Scotland*, p. 161; *Ann. & Mag. Nat. Hist.* ser. 5, 1887, vol. xix. p. 97.

For descriptions of this and the two following species see my paper in the 'Annals' of 1887.

Hab. Cullercoats, Northumberland; Guernsey, 1865; Starcross, Devon, 1884 (*A. M. N.*); Banff (*T. Edward*); Jersey (*Sinel*): *Mus. Nor.* Firth of Forth! (*T. Scott*).

Distribution. Naples, 1887* (*A. M. N.*); Adriatic (*Claus*): *Mus. Nor.* Goletta (*G. O. Sars*), Black Sea (*Czerniavsky*).

If I am right in considering Czerniavsky's *S. jaltensis* to be the same as *S. crassipes*, Sars, the former, though described as sexually mature, must be considered as not fully developed. It is in this light that I regard it.

4. *Cynthilia Brooki*, Norman.

1886. *Siriella Brooki*, Norman, *Fourth Annual Rep. Fishery Board Scotland*, p. 162; *Ann. & Mag. Nat. Hist.* ser. 5, 1887, vol. xix. p. 98.

Hab. Tarbert, Loch Fyne, 1887 (*Scottish Fishery Board*): *Mus. Nor.*

5. *Cynthilia armata* (Milne-Edwards).

1887. *Cynthia armata*, M.-Edwards, *Hist. Nat. d. Crust.* ii. p. 463 (mas vide G. O. Sars).

1853. *Mysis Griffithsæ*, Bell, *Hist. Brit. Crust.* p. 342.

Mysis rostratus, Guérin, *Iconog. Crust.* pl. xxiii. fig. 3 (probably).

1870. *Siriella armata*, G. O. Sars, *Middel. Mysider*, p. 96, pl. xlv.

1882. *Siriella (Rhinomysis) Griffithsæ*, *armata*, *rostrata*, and *diversa*, Czerniavsky, *l. c.* fasc. i. pp. 97, 98, 99, fasc. iii. pp. 35, 36, 37.

1886. *Siriella armata*, Norman, *Fourth Report Fishery Board of Scotland*, p. 162; *Ann. & Mag. Nat. Hist.* ser. 5, 1887, vol. xix. p. 99.

* Young taken in some numbers, but no fully developed specimens.

Hab. Firth of Clyde (*D. Robertson*); St. Andrews (*M'Intosh*); Tarbert, Loch Fyne (*Scottish Fishery Board*), Starcross, Devon (*C. Parker*); Jersey (*Sinell*): *Mus. Nor.* Plymouth! (*Spence Bate*); Castleton, Isle of Man! (*G. S. Brady*); Torquay (*Griffiths*); Weymouth (*W. Thompson*); Firth of Forth (*T. Scott*).

Distribution. Trieste (*Vienna Museum*): *Mus. Nor.* Goletta (*G. O. Sars*).

6. *Cynthia frontalis* (Milne-Edwards).

1837. *Mysis frontalis*, Milne-Edwards, Hist. Nat. d. Crust. vol. ii. p. 459.

1845. *Mysis frontalis*, Lucas, Anim. antic. d'Algérie, Crustacés, p. 49, pl. iv. fig. 7.

? 1853. *Mysis producta*, Gosse, Ann. & Mag. Nat. Hist. ser. 2, vol. xii. p. 156, pl. vi. fig. 5 a, b.

1863. *Mysis frontalis*, Heller, Crust. d. südlichen Europa, p. 303.

1876. *Siriella frontalis*, G. O. Sars, Middel. Mysider, p. 91, pls. xxiv., xxv.

1882. *Siriella (Rhinomysis) producta*, Sars, and *frontalis*, Czerniavsky, l. c. fasc. i. pp. 98, 99, fasc. iii. pp. 36, 37.

1884. *Pseudosiriella frontalis*, Claus, "Kennt. d. Kreislaufsorgane der Schizopoden u. Decapoden," Arbeiten Zoolog. Inst. Wien, vol. v. Heft iii. p. 6.

The *M. producta* of Gosse and the *M. Griffithsia*, Bell, may be referable either to this species or the last.

Rostrum of great size, forming a large subtriangular and acutely pointed plate, much longer than the eyes and reaching beyond the middle of the long peduncle of the antennules. *Eyes* narrow, cylindrical. *Antennules* with very long peduncle, basal joint longer than the two following combined, last with four setæ on the inner margin; inner filament unusually thick. *Antennal scale* rather shorter than peduncle of antennules, subrhomboidal, widening distally, extremity very obliquely truncate and reaching far beyond the spine of the outer margin. *Legs* more stoutly built than in *P. armata*. *Telson* lanceolate, very long, subequal to two preceding segments in length; marginal spines very numerous and towards the extremity very unequal in length; series of eight to seventeen much smaller and equal-sized spines alternating with very much larger spines, the narrowly rounded apex with two of the large spines at the corners and three or four small spines between them. *Inner uropods* rather shorter than telson; inner margin with numerous spines, larger towards extremity, somewhat unequal in length towards the base. *Outer uropod* with about thirty spines on the outer margin, the second joint about one third longer than broad.

In the *male* the pleopods have the branches very long, composed of twelve to fourteen articulations; the inner branch furnished at the base with a lateral leaf-like process (as in the genus *Leptomysis*) instead of the bilobate and convoluted organs usual in the genus *Siriella*. Length 25 millim.

In consequence of the absence of convolution in the organ attached to the pleopods of the male in this species Claus has constituted a genus for its reception under the name *Pseudo-siriella*.

Hab. Plymouth, 3 fath., August 5, 1889 (*A. M. N.*). "*Mysis producta*" was taken by Gosse at Weymouth.

Distribution. Adriatic (*Claus*): *Mus. Nor.* Nice (*M. Edwards*); Algiers (*Lucas*); Goletta, Cagliari, Malta, and Syracuse (*G. O. Sars*); Black Sea (*Grebinitzky*).

Subfam. II. *GASTROSACCINÆ*.

Genus 2. *GASTROSACCUS*, Norman, 1869.

= *Acanthocaris*, Sim. 1872, and *Pontomysis*, Czerniarsky, 1882.

Carapace deeply emarginate dorsally behind and usually cut into lobes at that part. *First segment of pleon* in female provided with a very large epimeral process which acts in support of the incubatory pouch; that pouch is formed of two pairs of plates. *Eyes* small, cylindrical. *Peduncle of antennules* of great length and very strongly built, their outer filament much swollen at the base. *Antennal scule* small, shorter than peduncle, outer edge naked, terminating in a spine-point. *Legs* having tarsus multiarticulate, bearing spines as well as setæ at each articulation; no nail; *first pleopods* in female well developed, consisting of an elongated curved cylindrical peduncle (which is wider at the extremities than in the middle) and two minute one-jointed branches; remaining pleopods in female very small and simple. *Telson* quadrangular, elongated, with a short cleft at the apex; this cleft margined with serrations, which are larger distally; sides of telson bearing spines of unusually large size. *Outer uropods* one-jointed, their outer edge beset with a series of strong spines.

In the *male* the sexual appendage of the last joint of peduncle of antennules is small and merely nodulous. All the pleopods are biramous and in a great measure formed for swimming. Peduncle of first pair margined with long setæ; peduncles of remaining pairs naked; inner branch of first,

fourth, and fifth pairs very small; outer branch of fourth pair very long, consisting of about seven articulations, wholly devoid of setæ and gradually becoming more slender distally.

1. *Gastrosaccus spinifer* (Goës).

1863. *Mysis spinifera*, Goës, "Crust. decapoda podoph. marina Sueciæ &c." (Eftvers. K. Vet.-Akad. Hand. xx.), p. 14 (separate copy).
 1862. *Gastrosaccus sanctus*, Norman, Brit. Assoc. Rep. for 1867, p. 438; and 1869, "Last Report Shetland Dredging," Brit. Assoc. Rep. for 1868, p. 268.
 1872. *Acanthocaris Livingstoniana*, G. Sim, "Stalk-eyed Crust. N.E. Coast of Scotland" ("Scottish Naturalist"), p. 4 (separate copy), pl. iv. fig. B 1-6.
 1880. *Gastrosaccus spinifer*, Stebbing, Ann. & Mag. Nat. Hist. ser. 5, vol. vi. pp. 114 and 328, pl. iii.
 1882. *Gastrosaccus spiniferus*, Czerniavsky, l. c. fasc. i. p. 87, fasc. iii. p. 5.
 1890. *Gastrosaccus sanctus*, Meinert, Vidensk. Udbytte af Kanonbaaden, "Hauch's" Togter. Crust. Malacostraca, p. 207.

Central portion of hind margin of carapace cleft into a number of fringe-like filaments. *Fifth segment of pleon* dorsally terminating in a produced spine-shaped process. *Antennules* with three strong spines on outer margin of second joint of peduncle, inner margin of third joint without conspicuous setæ. *Antennal scale* reaching middle of second joint of peduncle of antennules, its apex not extended beyond extremity of spine of outer margin. *Telson* with six to eight very large spines on margin, the two distal spines not conspicuously larger than preceding. *Inner uropods* slightly longer than the telson, having nine to eleven spines on the inner margin. *Outer uropods* having the apex bluntly and somewhat obliquely rounded, its outer margin with about thirteen to seventeen large closely-set spines, which are ciliated on the distal margins and have their apices of peculiar form, the edge being folded over, as though a cone-like hollow process was thus formed.

In the *male* the third pleopods have the ultimate joint bearing two small spines on the edge and terminating in two equal-lengthed spine-like processes, one of which is ciliated at the edge. Length 20 millim.

Hab. Shetland (*A. M. N.*), Banff (*T. Edward*), Moray Firth (*T. Scott*), Firth of Clyde (*D. Robertson*); Starcross, Devon (*C. Parker*); *Mus. Nor.* Aberdeen (*Sim*); Whitby (*Stebbing*); off Bo'ness, Firth of Forth (*T. Scott*).

Distribution. Bahusia in Sweden (*Lovén*, fide *Goës*); Denmark (*Meinert*); mouth of the Seine (*de Kerville*).

2. *Gastrosaccus sanctus* (Van Beneden).

1860. *Mysis sancta*, P. J. van Beneden, Recherches sur la Faune littorale de Belgique. Crustacés, p. 17, pl. vi. figs. 1-4.
 1876. *Gastrosaccus sanctus*, G. O. Sars, Middelhavets Mysider, p. 56, pls. xxi., xxii., xxiii., ♂ ♀.
 1882. *Gastrosaccus sanctus*, Czerniavsky, l. c. fasc. i. pp. 85, 86, fasc. iii. pp. 2, 3, 4.
 1882. *Pontomysis caucasica*, Czerniavsky, l. c. fasc. i. p. 79, fasc. iii. p. 6, pl. iv. figs. 4-20.
 1885. *Gastrosaccus sanctus*, Carus, Prodromus Faunæ Mediterraneæ, p. 467.

Hinder margin of carapace dorsally furnished with two lobes, one on each side of the centre, which are projected upwards and forwards. *Fifth segment of pleon* not furnished with a dorsal spine. *Antennal scale* with the slightly oblique apex scarcely extending beyond the spine of outer margin; penultimate joint of peduncle of antennæ with five plumose setæ on inner margin, last joint with three. *Legs* with tarsus composed of 7-14 articulations, the number of articulations increasing on the posterior limbs. *Telson* shorter than preceding segments, with six spines on each side. *Inner uropods* with about six spines on inner margin. Length about 13 millim.

"*Maris appendices genitales subcylindricæ, apice irregulariter lobatæ extus setis ciliatis sex ornatæ. Pedes ejus spurii omnes natatoriæ et longe setiferi, ramo exteriori in 1mo et 2do pari 9-articulato, in paribus 2 posterioribus 8-articulato: pedes spurii 3tii paris parte basali bene evoluta, ramo interiore structura eadem ac in 2do, 8-articulato, articulo basali extus processu brevi laminari instructo, ramo exteriori styliformi, triplo fere longiore, in segmenta 4 sensim et longitudine et latitudine decrescentia diviso, ultimo tenuissimo aculeis apicalibus 3 parvis armato.*" (G. O. Sars.)

Hab. Jersey, 1884 (*Sinel*): *Mus. Nor.*

Distribution. Naples, 1887 (*A. M. N.*); Belgium (*Van Beneden*); Goletta and Naples (*G. O. Sars*); Boulogne (*Giard*).

3. *Gastrosaccus Normani*, G. O. Sars.

1876. *Gastrosaccus Normani*, G. O. Sars, Middelhavets Mysider, p. 65, pls. xxiv., xxv.
 1882. *Gastrosaccus Normani*, Czerniavsky, l. c. fasc. i. p. 87, and fasc. iii. 1885, pp. 2, 3, 5.
 1885. *Gastrosaccus Normani*, Carus, l. c. p. 467.

Hinder margin of carapace simple. No dorsal spine on

fifth segment of pleon. *Antennules* with only two small spines on outer margin of second joint, third joint having five spine-like setæ on inner margin. *Antennæ* with only one seta on inner margin of the penultimate and last joint of peduncle; apex of scale extending considerably beyond the termination of outer margin. *Telson* longer than preceding segment, with about ten spines on each margin. *Legs and uropods* nearly as in *G. sanctus*. Length about 13 millim.

"*Maris appendices genitales* subfusiformes, medio valde incrassatæ, setis modo 3 instructæ. *Pedes spurii* ab iisdem speciei antecedentis sat discrepantes. 1mum par bene evolutum structura fere ut in *G. sancto*, 2dum par vix natatorium, ramis forma dissimili setis ciliatis carentibus, externo cylindrico, paulo flexuoso 8-articulato, articulis 4 ultimis extus aculeo tenui et lanceolato armatis, interno paulo brevior, valde flexuoso, sigmoideo, 6-articulato, articulo primo sat magno et laminari, ultimis 3 tenuissimis, setis apicalibus 2 parvis; tertium par parte basali apice oblique truncato, angulo exteriore in processum securiformem producto, ramo interno perbrevis, et rudimentari appendicem modo parvam uniarticulatam formante, externo vero valde elongato, styli-formi, dimidiam postabdominis longitudinem fere æquante, in segmenta 4 diviso, 2 anterioribus elongatis, 2 posterioribus dimidia parte brevioribus, aculeis apicalibus 2 brevibus; paria 2 posteriora minima, parte basali brevi, subtriangulari, ramo externo modo 3-articulato setis paucis ornato."

Hab. Off Rockall, 'Porcupine,' 1869; off Valentia, Ireland, 1870 (*A. M. N.*).

Distribution. Naples, 1887 (*A. M. N.*); Goletta, Syracuse, Naples, and Spezzia (*G. O. Sars*).

Genus 3. ANCHIALUS, G. O. Sars, 1876.

Rostrum more or less produced. *Antennal scale* unusually small, outer margin naked, terminating in a spine-point, extremity oblique. *Labrum* drawn out into a long point, which is slightly serrated on the margins. *Legs* with distal portion (tarsus) divided into several articulations, not unguiculate. *Marsupial pouch* formed of four pairs of lamellæ. *First pleopods* in female one-jointed, wider at base, then cylindrical; remaining pleopods rudimentary. *Telson* very large, cleft at the extremity, sides with very numerous ciliated spines. *Inner uropods* having inner margin edged throughout with spines of unequal length. *Outer uropods* one-jointed, outer margin spined; all setæ of uropods very short.

Male. Peduncle of antennules with sexual appendage very small, tubercular. First peræopods stronger than the rest; distal joints short, expanded, furnished with long strap-formed appendages. Pleopods with largely developed peduncle, the first consisting of a single branch, the rest with two multi-articulate branches, and a subovate laminary plate at the base of the inner branch; outer branch of fourth pair about three times as long as inner, multiarticulate (ten articulations), terminating in not long spiniform setæ.

Anchialus agilis, G. O. Sars.

1870. *Anchialus agilis*, G. O. Sars, Middelhavets Mysider, p. 70, pls. xxvi.-xxviii.

1883. *Anchialus agilis*, Czerniavsky, l. c. fasc. iii. p. 42.

1885. *Anchiulus agilis*, Carus, l. c. p. 463.

This little species is of very robust form, the breadth both of cephalothorax and pleon being greater in proportion to their length than in any other European Mysidean, the cephalothorax wider behind than in front. *Kostrum* somewhat linguiform, of considerable size, concealing the greater part of first joint of antennules. Peduncle of *antennules* stout, of moderate length, first and third joints subequal. *Antennal scale* minute, scarcely reaching extremity of penultimate joint of peduncle of antenna, and not half as long as peduncle of antennules, subrhomboidal, rather more than twice as long as broad; outer margin naked, terminating in a spine, beyond which the apex is obliquely truncate, and is, as well as inner margin, ciliated; from the inner side of the first joint of the antennæ there springs a long spine, which is serrated on the edges. *Legs* having the fourth joint much longer than the third, and the tarsus composed of three articulations. *Pleon* having the epimera produced downwards and backwards, angulated, and edged with finely plumose setæ. *Telson* very large, as long as the long inner uropods, and half as long as the pleon, the margins straight, and gradually and but slightly converging from the base to the extremity, which is incised to a depth subequal to breadth of same part of telson; sides of telson with about thirty ciliated spines, terminal spines much larger than the rest, the cleft minutely and closely dentated. *Uropods* having the auditory apparatus small; inner uropods with inner margin edged with ciliated spines of unequal length and fine hairs; apex terminating in two spines of much larger size; outer margin edged with fine hairs. Outer uropod having inner margin edged with fine hairs, and the outer bearing about thirty simple subequal spines. Length 8 millim.

The *male* has the last joint of peduncle of antennules furnished with a small densely pilose tubercle, which scarcely reaches beyond the extremity of the joint from which it springs. The peræopods have the tarsus strongly spined. The pleon has not the epimera produced. The first feet are longer and stouter than the rest, and the terminal joints are furnished with seven curious long strap-formed appendages.

Hab. Plymouth, a single female, 1890 (*A. M. N.*).

Distribution. Naples (*A. M. N.*); Messina and Naples (*G. O. Sars*).

Subfam III. *HETEROMYSINÆ*.

Genus 4. *HETEROMYSIS*, *S. I. Smith*, 1874.

= *Chiromysis*, *G. O. Sars*, 1877 (non *Heteromysis*, *Czerniavsky*, 1882).

Body moderately robust. *Carapace* behind leaving two segments of cephalothorax partially uncovered; rostrum scarcely developed. *Eyes* small, on short stout peduncles. *Antennal scale* elliptic, small, setose on both margins. *First legs* quite unlike the rest, very much stouter and also longer; the propodal joint strong, composed of two articulations, the first long, furnished with spines and setæ on inner edge, the second very short; nail well developed. All the following legs are slender, the tarsus multiarticulate, ending in a slender setiform claw. *Telson* cleft at the extremity. *Outer uropods* setose on both margins, without a second joint.

Prof. *S. I. Smith* thus describes the male, which I have not seen:—"Terminal segment of the peduncle of antennule wanting the usual elongated sexual process, but having in its place a very dense tuft of long hairs . . . The appendages of the first five segments of abdomen alike in both sexes; short and rudimentary, and like the same appendages in the female *Mysis* . . . In life the males are semitranslucent and colourless, while in the females the antennulæ, the flagella of the antennæ, the ocular peduncles, the thorax with the marsupial pouch, and the articulations of the caudal appendages are beautiful rose-colour."

Heteromysis formosa, *S. I. Smith*. (Pl. IX. figs. 6-11.)

1873. *Heteromysis formosa*, *S. I. Smith*, U. S. States Fish and Fisheries Comm. Report, 1871-72, p. 553.

1879. *Heteromysis formosa*, *S. I. Smith*, "Stalk-eyed Crust. Atlan. Coast N. Amer.," Trans. Connec. Acad. vol. v. p. 101.

1882. *Heteromysis norvegica*, *G. O. Sars*, "Oversigt Norges Crustaceer, I.," Christ. Videnskab. Forhand. 1882, p. 54, pl. i. figs. 21, 22.

Rostrum short, obtusely rounded. *Eyes* small; peduncles short and thick. *Antennal scale* small, scarcely as long as peduncle of antenna, narrowly elliptic, about three and a half times as long as broad, setose all round. *First legs* strongly built, only seven-jointed; ischium and meros subequal in length, both strongly formed, the latter with 4 (6-8*, *S. I. S.*) spines and numerous setæ on front margin; penultimate articulation minute, subquadrate; finger largely developed. *Remaining legs* of usual Mysidean type; tarsus of 5-6 articulations; nail setiform. *Telson* short, length to breadth as about 5 to 3, cleft at the extremity; distal portion of lateral margins with 14-17 spines (11-16, *S. I. S.*); cleft with 16-22 serrations. *Inner uropod* having beneath the setæ on inner margin about 17-19 spines (17-18, *S. I. S.*). Length 8 millim.

I have united Smith's and Sars's species because, 1st, the number of spines on the carpus would appear not to be constant; 2ndly, because the serrations of the cleft sometimes reach the extremity, in other instances not. One of my specimens shows on one side the one condition, on the other the other.

Hab. Guernsey, 1865 (*A. M. N.*); Firth of Forth, 1888 (*T. Scott*): *Mus. Nor.*

Distribution. Coast of United States (*S. I. Smith*): *Mus. Nor.* Near Bergen, 6-10 fath. (*G. O. Sars*).

Prof. Smith says of this species: "The species was never found in abundance except hidden away inside dead bivalve shells, usually *Macræas*, dredged in 5-10 fath. As many as twenty were sometimes found in a single shell. The males and young were occasionally taken at the surface in the evening in Vineyard Sound." With this hint as regards the habits of the animal it may not hereafter prove so rare on the European coasts as it has hitherto seemed to be.

Subfam. IV. *LEPTOMYSINÆ*.

Genus 5. *ERYTHROPS*, G. O. Sars.

= *Nematopus*, G. O. Sars.

Eyes short, broad, flattened, brilliant red. *Antennal scale* short, linear; external margin not ciliated, terminating in a spine-point; in other cases the margin serrated. *Legs* very long and slender, filiform, tarsus of three articulations; nail

* In a specimen received from Prof. S. I. Smith I can only see four spines.

slender. *Telson* very short, not half as long as inner uropods, subquadrate, lateral margin naked; extremity broadly truncate, bearing four spines and two setæ. *Pleopods* in female small, simple; in male formed for swimming, with multiarticulate branches, and a lateral lobe springing from the base of the inner branch.

1. *Erythrops Goëssii*, G. O. Sars.

1863. *Mysis erythrophthalmus*, Goëss, Crust. decap. marina Sueciæ, p. 18.
 1866. *Nematopus Goëssii*, G. O. Sars, Beretning om en i Somm. 1865 foretagen Zool. Reise ved Kysterne af Christianias og Christiansands Stifter, p. 15.
 1870. *Mysis erythrophthalmus*, Jarzynsky, Præem. Cat. Crust. decap. maris albi et litt. Murman (Trudy Soc. Nat. Petropol. vol. i. fasc. ii.), p. 317.
 1870. *Erythrops Goëssii*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 24, pl. i.
 1883. *Erythrops Goëssii*, Czerniavsky, l. c. fasc. iii. p. 16.
 1889. *Erythrops Goëssii*, T. Scott, Seventh Annual Report Fishery Board of Scotland, p. 322.

Pleon much narrower than cephalothorax; colour white and hyaline, beautifully variegated with orange and yellow. *Rostrum* small and little prominent, but distinct and narrowly rounded. *Eyes* very large, flattened, broader than long; cornea reniform, much hollowed basally as seen from above, and occupying nearly two thirds of whole organ. *Antennal scale* linear, four times as long as broad, and of nearly equal width throughout, one fourth longer than peduncle of antennules; outer margin naked, terminated above in a spine, beyond which the oblique apex is projected to about twice the length of that spine. *Gnathopods* well developed and strong, combined length of the last two joints equal to the preceding; nail much shorter than the last joint. *Legs* shorter than usual in this genus, the hinder pairs gradually increasing in length; preceding joint not quite so long as tarsus, the first articulation of which is one third longer than the combined length of the two distal joints; last legs when bent backwards reach just beyond the fifth segment of pleon. *Telson* with breadth at the base slightly exceeding the length and twice as broad as at the extremity; sides converging, with nearly straight margins; truncated extremity slightly arcuated, the inner pair of spines twice the length of the outer. *Inner uropods* having the inner margin plain (*i. e.* not serrulated). Length 9–10 millim.

Hab. This species has been recently added to the British fauna by Mr. Thomas Scott, who in October, 1888, sent me

specimens for determination which he had procured in the Firth of Forth: *Mus. Nor.*

Distribution. West Norway (*G. O. Sars*); Klosterelv Fiord, East Finmark (*A. M. N.*): *Mus. Nor.* Göes gives as localities of this species Finmark (*Lorén*), Christiansund (*Lilljeborg*); Widebay, Spitzbergen, 40 fath., mud. Professor *G. O. Sars* records it from many localities in South as well as West Norway, and from the Lofoten Islands, in depths of 30–100 fath. White and Murman Seas (*Jurzynsky*).

2. *Erythrops elegans* (*G. O. Sars*). (Pl. X. fig. 10.)

1863. *Nemtopus elegans*, *G. O. Sars*, Beret. om en i Somm. 1862 foretagen Zool. Reise i Christianias og Trondhjems Stifter, p. 42.

1866. *Nematopus pygmæus*, *G. O. Sars*, Beret. om en i Somm. 1865 foretagen Zool. Reise af Christianias og Christiansands Stifter, p. 17.

1870. *Erythrops pygmæa*, *G. O. Sars*, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 33, pl. ii. figs. 20–23.

1883. *Erythrops pygmæa*, *Czerniavsky*, l. c. fasc. iii. p. 16.

1885. *Erythrops pygmæa*, *Carus*, l. c. p. 469.

1886. *Erythrops pygmæa*, *Norman*, Fourth Annual Report Fishery Board of Scotland, p. 156; Ann. & Mag. Nat. Hist. ser. 5, 1887, vol. xix. p. 93.

The smallest of all described Mysidea; pleon slightly narrower than the cephalothorax. *Rostrum* short, narrow, and obtusely pointed. *Eyes* rather longer than broad, triangular or pyriform, widening greatly distally, flattened; cornea occupying centrally about one third of total length. *Antennal scale* almost exactly as in *E. Goësi*. *Gnathopods* small and weak, antepenultimate joints longer than the two following, terminal joint as long as the joint from which it springs. *Legs* shorter than those of *E. Goësi*; last pair when bent backwards reaching a little beyond fourth segment of pleon, preceding joint subequal in length to the three articulations of the tarsus; first of these articulations in the anterior legs shorter than in the hinder, equal to the combined length of the two distal. *Telson* nearly as in *E. Goësi*, but the sides slightly arcuated (instead of straight), the extremity truncated in a straight line, and the four terminal spines of subequal length, though the outer are rather the shorter. *Inner uropods* with the inner margin plain (*i. e.* not serrulated). Length 9 millim.

Hab. This species was added to the British fauna by Mr. Thomas Scott, who sent the specimen for determination in 1885, which he had taken at Tarbert, in Loch Fyne, in shallow water; and in 1889 he procured it in the Moray Firth: *Mus. Nor.*

Distribution. I have dredged it at Solems Fiord, Florø, Norway, in 5 fath. Professor G. O. Sars has recorded it from Romsdals, Christiania, and Hardanger Fiords, in 5-12 fath.; and also in the Mediterranean at Messina and Naples.

3. *Erythrops serrata*, G. O. Sars. (Pl. X. fig. 11.)

1863. *Nematopus serratus*, G. O. Sars, Beret. om en i Samm. 1862 i 27-tagen Zool. Reise i Christianias og Trondhjems Stifter, p. 43.

1869. *Nematopus serratus*, Norman, "Last Report Dredging Shetland Isles," Brit. Assoc. Rep. for 1868, p. 270.

1870. *Erythrops serrata*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 27, pl. ii. figs. 1-12.

1883. *Erythrops serrata*, Ozerniavsky, l. c. fasc. iii. pp. 16, 18.

Form less slender than that of *E. Goëssii*; cephalothorax rather wider than pleon, on the ventral surface of each of its segments a shortly stalked rounded boss, beset thickly with strong spine-points; colour white, with a reddish spot on each side of each segment of pleon, and a band across the fourth, sometimes also a longitudinal line on each side of cephalothorax; the very large reniform eyes are of a lovely and brilliant ruby-red. *Rostrum* obscure, scarcely developed. *Eyes* almost as in *E. Goëssii*. *Antennal scales* narrowly linear, about one fourth longer than peduncle of antennules; length nearly five times that of breadth; external margin having the distal two thirds deeply serrated, or cut into 7-9 large spine-like processes, the most distal of which overlaps the extremity of the scale. *Legs* very long, the hinder pairs rapidly increasing in length, and the last when bent backwards reaching the basal portion of the telson; carpus shorter than the more distal portion of the limb; the succeeding articulation twice as long as the combined length of the two which precede the nail. *Telson* in form as in the other species, but the lateral margins slightly concave; the termination truncated in a straight line, the four terminal spines subequal in the female, but the outer pair one third shorter than the inner in the male. *Inner uropods* having the inner margin minutely serrulated throughout. Length 10-11 millim.

Hab. Dredged on a muddy bottom in 40-60 fath. in St. Magnus Bay, Shetland, 1867; and in 1870 in 80-100 fath. off Valentia, Ireland (A. M. N.); Moray Firth and Firth of Forth (T. Scott): *Mus. Nor.*

Distribution. Professor G. O. Sars has dredged this species in the Christiania and Hardanger Fiords, at Christiansund, and among the Lofoten Islands, in depths ranging from 30-150 fath.; and I have myself taken it off Sponholmene in the Hardanger Fiord, in 100 fath. Denmark (*Meinert*).

Erythrops serrata is at once distinguished from all other British Mysidea by the serrations of the outer margin of the antennal scale. A species, however, similar in this respect, *E. abyssorum*, G. O. Sars, occurs in Norway, but is distinguished from it by the extraordinary length of the peræopods, the last pair of which when bent backwards reaches beyond the uropods; by the greater production of the apex of the antennal scale, which considerably overtops the point of distal spine-process of outer margin; by the extremity of the telson not being truncated in a straight line, but slightly arcuated; and the inner margin of the inner uropods not being serrulated.

Genus 6. *MYSIDOPSIS*, G. O. Sars.

Eyes large, subglobose, somewhat flattened; pigment dark coloured. *Antennal scale* lanceolate, setose all round. *Maxillipeds* 5-articulated, *gnathopods* 6-articulated and very robust, both ending in a nail. *Legs* subequal; tarsus 4-articulated, and shorter than preceding joint, ending in a slender nail. *Telson* hollowed above, of moderate size, sides spined, extremity truncated or cleft (cleft simple, that is, not serrated). *Pleopods* in female less narrow than usual, lateral basal dilatation small; in male well developed, with multiarticulate swimming-branches; fourth pair with outer swimming-branch terminating in a single spine-like seta, densely ciliated at the extremity; last pair having, besides the narrow lateral basal lobe on the inner branch, a conical projection ending in a single seta. *Uropods*, *inner* with large acoustic organ, the spines of its inner margin confined to the neighbourhood of the acoustic organ; *outer* broader than usual.

1. *Mysidopsis didelphys* (Norman).

1863. *Mysis didelphys*, Norman, Trans. Tyneside Nat. Field-Club, vol. v. p. 270, pl. xii. figs. 9-11.
 1864. *Mysidopsis didelphys*, G. O. Sars, Beretning om en i Sommeren 1863 foretagen Zool. Reise i Christiania Stift, p. 27.
 1869. *Mysidopsis didelphys*, Norman, "Last Report Dredging Shetland," Brit. Assoc. Rep. for 1868, p. 267.
 1872. *Mysidopsis didelphys*, G. O. Sars, Monogr. Mysider, ii. p. 20, pl. vii.
 1883. *Mysidopsis didelphys*, Czerniavsky, l. c. fasc. iii. p. 24.

Body robust. Sides of cephalothorax converging gradually forwards into a broadly triangular short rostrum, with acute apex, which extends rather more than half the length of the first joint of the peduncle of the antennules. *Antennal scale* narrowly elongate-ovate, about one third longer than the

peduncle of the antennules; greatest breadth central, about, or rather more than, equal half the length, setose all round. *Telson* somewhat shorter than the uropods, contracted at one third its length, the portion posterior to the constriction being narrow; extremity narrowly truncate, with a well-developed spine at each corner (but no central spines); marginal spines 8-10, the first three or four separated by an interval from the following. *Inner uropods* narrow, a single spine on the inner margin opposite the otolithic process; otolithic area occupying scarcely more than one third of the total length. Length about 14-15 millim.

Hab. Forty miles off Tynemouth, Northumberland; Shetland; Firth of Clyde; off Valentia, Ireland (*A. M. N.*); Moray Firth; Firth of Forth, near May Island; Tarbert, Loch Tyne (*T. Scott*): *Mus. Nor.*

Distribution. Norway, in Christiania and Hardanger Fiords, Aalesund, Christiansund, and Lofoten Islands, 30-150 fath. (*G. O. Sars*); Denmark (*Meinert*).

2. *Mysidopsis gibbosa*, G. O. Sars. (Pl. X. fig. 8.)

1864. *Mysidopsis gibbosa*, G. O. Sars, Zool. Reise 1863 i Christiania Stift. p. 23.

1872. *Mysidopsis gibbosa*, G. O. Sars, Monogr. Mysider, ii. p. 23, pl. viii. figs. 1-13.

1883. *Mysidopsis gibbosa*, Czerniavsky, l. c. fasc. iii. p. 24.

1885. *Mysidopsis gibbosa*, Carus, l. c. p. 469.

1887. *Mysidopsis gibbosa*, Norman, Ann. & Mag. Nat. Hist. ser. 5, vol. xix. p. 93.

A much smaller species than the last.

Body robust, the pleon generally curiously bent upwards in the middle. *Rostrum* very small, scarcely developed. *Antennal scale* narrowly elongate-ovate, about three times as long as broad, rather more than half as long again as peduncle of antennæ, and about one third longer than peduncle of antennules, setose all round. *Telson* broader throughout than in last species, and distally more broadly truncated; this truncated extremity is furnished with two (rarely three) small spines in the centre, but none at the angles; lateral spines 11-18, no marked interval between the first three or four and the following. *Inner uropods* only slightly longer than the telson, scarcely more than twice as long as the otolithic area, 4-5 small spines within inner margin near the base, opposite the acoustic organ. Length about 6-7 millim.

Hab. Valentia, Ireland, 1870 (*A. M. N.*); Tarbert, Loch Fyne, 1885; and Firth of Forth, 1888 (*T. Scott*): *Mus. Nor.*

Distribution. Naples (*A. M. N.*), Adriatic (*Prof. Claus*); Norway (*G. O. Sars*): *Mus. Nor.* South and West Norway, 6–10 fath. (*G. O. Sars*); Denmark (*Meinert*); Goletta, Malta, Syracuse, Messina, Spezzia (*G. O. Sars*).

3. *Mysidopsis angusta*, G. O. Sars. (Pl. X. fig. 9.)

1864. *Mysidopsis angusta*, G. O. Sars, Zool. Reise 1863 i Christiania Stift, p. 30.

1870. *Mysidopsis angusta*, G. O. Sars, Monogr. Mysider, p. 27, pl. viii. figs. 14–24.

1883. *Mysidopsis angusta*, Czerniavsky, *l. c.* fasc. iii. p. 25.

1885. *Mysidopsis angusta*, Carus, *l. c.* p. 469.

1886. *Mysidopsis angusta*, Norman, Fourth Annual Report Fishery Board of Scotland, p. 158; Ann. & Mag. Nat. Hist. ser. 5, 1887, vol. xix. p. 94.

Body slender. *Rostrum* fairly developed, acute, but not reaching to half the length of the first joint of peduncle of antennules. *Antennal scale* narrow, linear, of nearly equal breadth throughout, 7–8 times as long as broad, twice as long as peduncle of antennæ and of antennules. *Telson* in form nearly as that of *M. gibbosa*, but narrower at the base in proportion to its length; apex cleft, the cleft narrow, and in depth equal to the breadth of the telson at the same part; sides of cleft smooth, and in this respect differing from all other species of *Mysidæ* which have a cleft in the telson; lateral spines 14–16, placed at nearly equal distances, the more distal spines somewhat increasing in size, the last situated at the point of the cleft being the largest. *Inner uropods* longer than telson; acoustic organ not occupying quite half its length; a single spine only on inner margin opposite otolithic area. Length 8 millim.

Hab. Banff (*T. Edward*); Moray Firth (*T. Scott*): *Mus. Nor.* Loch Fyne and Firth of Forth, to the east of Incheith (*T. Scott*).

Distribution. Norway (*G. O. Sars*): *Mus. Nor.* Christiania and Hardanger Fiords, and Aalesund, Norway; Naples (*G. O. Sars*).

4. *Mysidopsis hibernica*, sp. n. (Pl. IX. figs. 1–5.)

Rostrum short, bluntly rounded at the extremity. *Antennules* having the basal joint subequal in length to the two following. *Antennæ* with each of the last two joints of peduncle furnished at the inner side of the extremity with a long spined seta, in addition to ordinary plumose setæ. *Antennal scale* lanceolate, half as long again as peduncle of antennæ, and about four times as long as broad; second joint minute, as broad as long, bearing one pair of lateral

and three terminal setæ. *Mandible* with second and third joints of the palp remarkable on account of the dense clothing of spined setæ on both margins, and especially on the sides, they are of great length on the third joint; simple or plumose setæ are entirely absent*. *Macillipeds* and *gnathopods* remarkably massive and strong, terminating in a strong simple nail, on either side of which are several large spines which are ciliated on one margin. *Legs* having the 4-articulated tarsus strong and much shorter than preceding joint, nail slender. *Telson* lanceolate, shorter than inner uropods, gradually attenuating to the extremity, which is narrowly truncate, and armed with three pairs of spines, the inner pair small, the intermediate pair very long, the outer pair somewhat larger than the central pair; sides of telson with twenty spines of equal size, and about equal distances apart, arranged throughout the entire length. *Uropods* very narrow; inner pair with a group of five spines, closely packed, and increasing in length distally, arranged round the curve of the otolithic area; no spines beyond these. The *pleopods* of the male are of the general character in the genus; the specialized outer branch of the fourth pair consists of nine joints, and the antepenultimate bears, like the preceding joint, a pair of plumed setæ; the penultimate is without appendages, the last terminates in a long spine-like seta, which is densely ciliated towards the extremity. Length 15 millim.

One male and one female specimen were procured by me when in Dr. Jeffreys's yacht 'The Osprey,' at Valentia, Ireland, in 1870. I do not know under what circumstances as to depth &c. they were obtained, as I had only labelled the bottle which contained them "Valentia, 1870."

[To be continued.]

XVI.—Notes on the Genus *Coturnix*.

By W. R. OGILVIE-GRANT, Natural-History Museum.

THIS paper contains a short account of the species comprising this group and a brief synonymy of the several species, giving the various combinations of names (generic and specific) under which each has been described, and references to the principal illustrations, except in the case of *Coturnix*

* Spined setæ but short are often present, as in *M. didelphys*, at the extremity only of the distal joint, the other setæ being plumed or simple.

coturnix, where the species has been frequently figured. The generic characters, a key to the species, and their geographical distribution are also given, together with a few notes which it is hoped may prove useful to other ornithologists studying this group of Gallinæ.

COTURNIX*.

Tail short, soft, and rounded, covered by the upper tail-coverts, and composed of ten or twelve tail-feathers.

First primary equal to the third and slightly shorter than the second, which is the longest quill; tenth primary very short.

Axillaries long and white.

Key to the Species †.

- I. Outer web of the primaries with irregular bars and marks of buff.
 - A. Chin and throat white, with a black band commencing on the chin and passing down the middle of the throat *C. coturnix*, ♂.
 - B. Chin and throat bright rufous-chestnut, with the black band situated as above *C. capensis*, ♂.
 - C. Chin and throat dull brick-red, without any black markings *C. japonica*, ♂.
 - D. Feathers on the chin and sides of the throat white, short and rounded. No black band down the middle of the throat.
 - a. Size larger. Wing ca. 4.2 *C. coturnix*, ♀.
 - b. Size smaller. Wing ca. 3.8 *C. capensis*, ♀.
 - E. Feathers on the chin and sides of the throat elongate and lanceolate, usually margined on one or both webs with rufous. No black band down the middle of the throat. *C. japonica*, ♀.
- II. Outer web of the primaries uniform brown, not barred or marked with buff.

* The genus *Synoisus* appears to be very doubtfully distinct from *Coturnix*; so far as I can see, the only tangible character by which the two can possibly be distinguished is found in the axillaries, which are shorter and greyer in the former. I think it highly probable that *Synoisus* will have to be merged in *Coturnix*.

† *Coturnix Eminii*, ♂, recently described by Reichenow (Allg. deutsch. orn. Ges. Berlin, Bericht x. (7th Dec. 1891), p. 3), is undoubtedly the male of *Eccalfatoria alansui*, Verr.

- F. Chin and throat white, with a very clearly defined black anchor-shaped mark (a large black patch on the middle of the breast).
- c. General colour of the underparts buff *C. coromandelica*, ♂.
 - d. General colour of the underparts chestnut. *C. Delegorguei*, ♂.
- G. Chin and throat brick-colour or chestnut.
- e. Throat dull brick-colour. Size smaller. Wing ca. 4.1 *C. pectoralis*, ♂.
 - f. Throat bright brick-colour or chestnut. Size larger. Wing ca. 4.6 *C. novæ zealandiæ*, ♂.
- H. Chin and throat white or buff, without a black band down the centre.
- g. Chest-feathers without a submarginal band on either web.
 - a'. Ground-colour of the wing-coverts sandy buff, underparts pale buff. *C. coromandelica*, ♀.
 - b. Ground-colour of the wing-coverts blackish grey, underparts rufous-buff or dull chestnut *C. Delegorguei*, ♀.
 - h. Chest-feathers with a submarginal black band on either web.
 - c'. The black bands are not confluent in the median line, but separated by a buff isthmus. Size smaller. Wing ca. 4.1. *C. pectoralis*, ♀.
 - d'. The black bands are confluent in the median line and form a W-shaped mark. Size larger. Wing ca. 4.6 . . *C. novæ zealandiæ*, ♀.

While this paper was passing through the press the January number of the *Journ. für Orn.* arrived in England. It contains a full description and coloured figure of the so-called *C. Emini*, which must be added to the synonymy of *E. Adunsoni*.

Coturnix coturnix. (Woodcut, fig. I.)

- Tetrao israelitarum*, Hass.-lg. Reise Palaest. p. 331 (1762).
Tetrao coturnix, Linn. S. N. i. p. 278 (1766).
Perdix coturnix, Lath. Ind. Orn. ii. p. 651 (1790); Vieill. Faun. Franç. p. 255, pl. cxi. figs. 2 and 3 (1825); Selb. Ill. Brit. Orn. i. p. 437, pl. lxii. (1833); Korner, Skand. Fogl. p. 13, pl. xxviii. fig. 5 (1839-40).
Ortygion coturnix, Keyserl. u. Blas. Wirbelth. Europa's, p. 202 (1840).
Ortyx coturnix, Chenu et Desm. Encycl. Ois. vi. p. 154 (1854).
Coturnix coturnix, Licht. Nomencl. Av. p. 84 (1854).
Turnix coturnix, Salv. Ibis, 1859, p. 353.
Perdix cothurnix, Vieill. N. Dict. d'Hist. Nat. xxv. p. 248 (1817).
Coturnix alba, Bechst. Nat. Deutschl. iii. p. 581 (1793).
Coturnix varia, Bechst. l. c. p. 581 (1793).

- Coturnix major*, B.-ch.-t. l. c. p. 581 (1793).
Coturnix nigra, B.-ch.-t. l. c. p. 582 (1793).
Coturnix dactyli unans, Temm. Pix. et Gall. iii. pp. 473, 740 (1815);
 Steph. Shaw's Gen. Zool. xi. p. 361, pl. xxiv. (1819); Gould, B.
 Europe, iv. pl. cclxi. (1837); Rowley, Orn. Misc. i. pl. xii. figs. 3
 and 4 (1877).
Coturnix dactylis unans?, var. *indicus*, Hodge, in Gray's Zool. Misc.
 p. 25 (1844); id. Ic. m. ined. in Brit. Mus. nos. 130, 131.
Coturnix communis, Vieill. Tabl. Encycl. Méth. i. p. 217, pl. xvi. fig. 2
 (1823); Fitz. Atl. Nat. Vog. ii. p. 238 (1864); Fritsch, Nat. Vog.
 Europa, pl. xxx. figs. 7 and 8 (1871); Dress. B. Europe, vii. pp. 143,
 476 (1878); Hume and Marsh. Game B. Ind. ii. p. 134, pl. (1879).
Ortyx communis, Lemett, Cat. Ois. Seine Inf. p. 12. (1879).
Coturnix communis orientalis, Bogdanow, Cons. Av. Imp. Ross. fasc. i.
 p. 44 (1884).
Coturnix media, Brehm, Handb. Vog. Deutschl. p. 528 (1831).
Coturnix minor, Brehm, l. c. p. 529 (1831).
Coturnix europæus, Swains. Class. B. ii. p. 344 (1837).
Coturnix vulgaris, Bout. Orn. Dauphiné, p. 72, pl. xliii. fig. 1 (1843).
Coturnix vulgaris, B. Baldani, Severtz. Turkest. Jevotnie, p. 65 (1873).
Coturnix Baldani, Naum. fide Brehm, Vogelfang. p. 274 (1855).
Coturnix leucogenys, Brehm, Naumannia, p. 285 (1855).
Coturnix chinensis, Swinh. Ibis, 1860, pp. 63, 353.
Synœcus lodoisæ, Verr. et Des Murs, Rev. et Mag. Zool. 1862, p. 225,
 pl. xi.
Synœcus lodoisæ, Saunl. Ibis, 1860, p. 303.
Perdortyx lodoisæ, Montess. Mém. Soc. Sienne, vi. p. 36 (1859).
Coturnix ypsilophorus, Bosc?, fide Gray, Hand-l. B. ii. p. 268 (1870).

Range. Æthiopian and Palæarctic Regions and India.

Race a. *Coturnix capensis*.

- Perdix coturnix*, Webb & Berth. Orn. Can. p. 29 (1836-44).
Ortygon coturnix, Godman, Ibis, 1872, p. 219.
Coturnix coturnix, Sharpe's ed. Layard B. S. Afr. p. 603 (1884) [part.].
Coturnix dactylis unans, Strickl. & Sclat. in Jard. Contr. Orn. 1852,
 p. 152.
Coturnix dactylis unans, Holub & Pelz. Beitr. Orn. Sudaf. p. 188
 (1852).
Coturnix communis, Newton, Ibis, 1863, p. 454.
Coturnix capensis, Licht. fide Gray, Hand-l. B. ii. p. 268 (1870).

Range. South Africa south of about 15° S. lat., Mauritius, Madagascar, Comoro Islands, Cape-Verd Islands, Canaries, Madeira, and Azores.

Perhaps no species of Game Birds have been more confused, and their changes of plumage less understood, than the Common Quail (*Coturnix coturnix*) and its near ally the Japanese Quail (*C. japonica*); and I am pleased to say that I have now at last discovered definite and well-marked characters by which both the males and females of these two species may be readily distinguished, while the intermediate

forms are, as I shall presently show, undoubtedly the results of interbreeding.

Coturnix japonica is the resident bird found in Japan and China, and sometimes occurs in N.E. India and Burmah, as there are specimens of this species in the British Museum obtained in Bootan and Karen-nee. The male is characterized by the uniform dull brick-red throat without any trace of a black band down the middle, and the female by having the feathers on the chin and sides of the throat elongate and lanceolate and of much the same structure as those found in *Perdix barbata*.

The typical form of *Coturnix coturnix*, commonly known as the migratory Quail of Europe, has the throat pure white, the male having a black anchor-shaped mark down the middle, while in the female the feathers on the sides of the throat are short and rounded, never elongate as in the female of *C. japonica*. This bird ranges over an enormous area, practically the whole of the Ethiopian and Palæarctic Regions, extending in the south to South Africa and in the east to China and Japan. In the islands surrounding the African coast, namely Mauritius, Madagascar, the Comoro Islands, the Cape-Verd Islands, the Canaries, Madeira, and the Azores, and also in the southern part of Africa south of about 15° S. lat., a resident subspecies of *C. coturnix*, known as *C. capensis*, is found, which is distinguished from the typical form by its somewhat smaller size and by having the throat of the male bright rufous-chestnut with a black anchor-shaped mark down the middle. In Japan and China the migratory Quail (*C. coturnix*), as already pointed out, inhabits the same tract of country during the breeding-season as *C. japonica*, and there cannot be the slightest doubt that the two species frequently interbreed, with the result that all sorts of intermediate hybrids are produced. These intermediate plumages are most noticeable among the male hybrids. For instance, some have the dull brick-red throat of *C. japonica* and the black anchor-shaped mark of *C. coturnix*, others have only the upper two thirds of the throat dull red and the lower third white, while again a third lot have in addition a black band down the centre of the red part, and all kinds of intermediate stages between these three examples may be found. These hybrids are, so far as I know, generally only found in Mongolia, China, and Japan, though there is one specimen in the very large series of the British Museum said to have been obtained in Bootan. Equally also, though of secondary importance, *C. coturnix* interbreeds freely with the red-throated resident race (*C. capensis*) in South Africa and the

islands surrounding the coast, and the results are seen in the many male birds from South Africa and Southern Europe &c. in which the white parts on the sides of the head and throat are more or less suffused with the bright rufous-chestnut of the resident bird.

The females of course are not to be distinguished. I may add that Indian examples of *C. coturnix* are, generally speaking, very pure bred and seldom show any trace of rufous on the sides of the head and throat.

There are two specimens in the British Museum of the curious melanistic variety of *C. coturnix* which occurs in Spain. They were obtained by Mr. Howard Saunders in the marshy neighbourhood of Valencia. In the male the general colour of the upper parts is black, with narrow buff or rufous cross bars; the pattern formed by the wide golden-buff shaft-streaks on the feathers of the mantle and on each side of the body is normal; the greater part of the sides of the head, the chin, and throat are black, with here and there a white feather; the chest-feathers are mottled with black, and the feathers of the sides and flanks are black dotted with rufous and with a wide white shaft-stripe down the middle of each. In the female all the underparts are suffused with dull brown.



II.

I.

I. *Coturnix coturnix*, ♀ ad.

II. *Coturnix japonica*, ♀ ad.

Coturnix japonica. (Woodcut, fig. II.)

Coturnix vulgaris japonica, Temm. & Schl. Faun. Jap. p. 103. pl. lvi. (1842).

Coturnix japonica, Blakist. Ibis, 1862, p. 329.

Coturnix coturnix, Rulde, Reise Ost-sib. ii. p. 306 (1863).

Coturnix japonica, Dybowski, J. f. O. 1868, p. 337 (descr. nulla); Prjev. J. f. O. 1872, p. 138.

Coturnix communis, Blyth, Mamm. & B. Burma, p. 151 (1875);
Prjev. in Rowley's Orn. Misc. ii. p. 424 (1877).

Coturnix ussuriensis, Bogd. Consp. Av. Imp. Ross. fasc. i. p. 45 (1884).

Range. Japan, Manchuria, S.E. Mongolia, and China as far south as Canton. Specimens have also been obtained in Bhootan and Karen-nee.

Young males have the elongate throat-feathers like those of the adult female of *C. coturnix* above described, and the middle of the throat is suffused with dull brick-red; otherwise the plumage resembles that of the male adult.

In a rather more mature male *one side of the throat* has lost the immature elongate feathers like those of the female and assumed the short, rounded, dull rufous feathers characteristic of the male adult.

Prjevalsky is, as far as I can find, the only person who has previously noted the elongate feathers on the throat of this bird. He writes (Rowley's Orn. Misc. ii. p. 424):—"A male was obtained in S.E. Mongolia in June. It differs from the European bird in the longer lancet-shaped feathers of the sides of the throat, which are like those of *Perdix barbata*. I cannot say if this is a constant or only an occasional case, as we have got but one specimen for comparison."

This specimen, if correctly sexed, was no doubt a young male. Prjevalsky also remarks (l. c.), "This bird [*C. japonica*] is easily distinguished from the European one by its voice . . . and from the end of March to the middle of summer the call-note of the males can be heard daily, consisting of some deep hollow sounds several times repeated in quick succession."

Coturnix coromandelica.

Coromandel Quail, Lath. Gen. Syn. ii. pt. ii. p. 789 (1783).

Tetrao coromandelicus, Gmel. S. N. i. pt. ii. p. 764 (1788).

Perdix coromandelica, Lath. Ind. Orn. ii. p. 654 (1790).

Coturnix coromandelica, Vieill. Tabl. Encycl. Méth. i. p. 221 (1823);
Gould, B. Asia, vii. pl. ix. (1854); Hume & Marsh. Game B. Ind. ii.
p. 152, pl. (1879).

Coturnix coromandelicus, Blyth, Mamm. & B. Burma, p. 151 (1875).

Perdix textilis, Temm. Pl. Col. v. pl. xl. [no. 35] (1824); Drapiez,
Dict. Sci. Nat. viii. p. 429, pl., fig. 1 (1824).

Coturnix textilis, Temm. Fig. et Gall. iii. pp. 512, 742 (1815); Less.
Traité d'Orn. p. 509, pl. xc. fig. 1 (1831); Jard. Nat. Lib., Orn. iv.
p. 116, pl. viii. (1834).

Coturnix textilis?, var. *pluvialis*, Hodgs. in Gray's Zool. Misc. p. 85
(1844); id. Icon. ined. in Brit. Mus. nos. 119 and 120.

Perdix olivacea, Buchan. P. Z. S. 1831, p. 123.

Range. Greater part of the peninsula of India; Assam,

Manipur, Chittagong, and Pegu. It is no doubt also found in Arrakan.

The female of this species may be readily distinguished from the female of *C. coturnix*, which it otherwise closely resembles, by the absence of all buff or rufous bars and mottling on the outer webs of the primaries.

Coturnix Delegorguei.

Coturnix Delegorguei, Deleg. Voy. Afr. Austr. ii. p. 615 (1847); Jackson, Ibis, 1850, p. 533.

Coturnix histrionica, Hartl. Rev. et Mag. Zool. i. p. 495 (1849).

Coturnix furnasini, Bianc. Spec. Zool. Mos. fasc. xvi. p. 399, pl. i. fig. 2 (1850); id. Mem. Acc. Sci. Bolon. (2) iv. p. 521, pl. ii. fig. 2 (1865).

Coturnix crucigera, Heugl. Vög. N.O.-Afr. p. 51. no. 533 (1856).

Range. Africa, south of about 15° N. lat.

This species resembles *C. coromandelica* in having the outer webs of the primaries in both sexes uniform brown, not barred or marked with buff.

Coturnix pectoralis.

Coturnix pectoralis, Gould, P. Z. S. 1837, p. 8; id. Syn. B. Austr., text and pl., fig. 1 (1837-38); id. B. Austr. v. pl. lxxxviii. (1848);

Diggles, B. Austr. ii. pt. xv. pl. xcv. (1867).

Synoicus australis, Ramsay, Ibis, 1865, p. 86.

Range. Australia, Tasmania.

Coturnix novæ-zealandiæ.

Coturnix novæ-zealandiæ, Quoy & Gaim. Voy. Astrol., Zool. i. p. 242, pl. xxiv. fig. 1 (1830); Gould, Syn. B. Austr., text and pl., fig. 2 (1837-38); Bull. B. New Zeal. p. 161, pl. (1873); Sharpe, in Voy. Ereb. & Terr., Birds, App. pp. 10, 27, pl. viii. (1875); Bull. Man. B. N. Zeal. p. 43, pl. xix. (1882); id. B. N. Zeal. i. p. 225, pl. xxiii. (1888).

Range. New Zealand [said to be extinct.]

XVII.—*Descriptions of Three new Species of Saturniidae in the Collection of the British Museum.* By W. F. KIRBY, F.L.S., F.E.S., Assistant in Zoological Department, British Museum (Natural History).

[Plate XI.]

Bunœa Mitfordi. (Pl. XI. fig. 1.)

Exp. al. 112 millim.

♂. Dark blackish brown, collar narrowly red, and undersur-

face of legs red. Wings with scattered red scaling in the cell, round the vitreous spot, and towards the costa beyond, on the anterior wings, and towards the hind margin of the posterior wings. Anterior wings with an indistinct nearly straight grey line running from within the apex to the hinder angle; it curves slightly outwards before reaching the costa, and is nearer the apex than the hinder angle, but does not reach it. The vitreous spot is large, conical, terminating basally in a slight inward curve. Towards the hinder angle is a large patch of whitish dusting, crossed by a white bar, and looking as if the wing had been rubbed. Posterior wings with a large ocellus; pupil subvitreous, oval, surrounded by a tawny iris and by an inner black and outer red ring. Outside this is a curved grey line, more distinct than on the anterior wings, hardly extending to the costa or inner margin.

Underside brownish grey, darker outside the transverse lines, which here show brown, with some grey scaling on the inner side, but are better defined, nearer the base, and straighter than above. The red scaling is fainter than above. There is a large chalky-white patch on the anterior wings, covering the space from just below the vitreous spot to the hinder angle. Posterior wings with the ocellus reduced to the vitreous spot; within it runs a suffused brownish band from the costa to the inner margin. Anterior wings pointed and strongly hooked at the tip. Posterior wings long, and slightly produced at the anal angle. Antennæ reddish, especially beneath.

Hab. Sierra Leone. Presented by C. B. Mitford, Esq. Taken "by path over river in dense bush."

A very remarkable species, not closely allied to any other. It has a superficial resemblance to *B. ebilis*, Streck., from the Congo, which is a much larger insect; but it also appears to have some affinities with *Gonimbrasia*, though it cannot well be referred to that genus.

Gonimbrasia rubricostalis. (Pl. XI. fig. 2.)

Exp. 119 millim.

♂. Brown, anterior wings with two transverse blackish lines, not very well marked—the first nearly straight, about one third of the length of the inner margin from the base, and with some scattered bluish-white scaling on the outside, especially on the costa; the outer runs obliquely from two thirds of the length of the inner margin to the costa a little before the apex; it is double (most distinctly so towards the inner margin) and filled up with bluish white; within this

line the middle portion of the wing is browner, and on the costa is a long patch of bluish-white scaling. Vitreous spot punctiform, hardly visible above. Posterior wings with the costa pink above the ocellus nearly to the tip, and the inner margin is also slightly bordered with pink. Ocellus of moderate size; vitreous pupil very small; iris yellowish, followed by a black and a buff ring; between this and the base is a curved bluish-grey line, and there is another slightly edged with black on each side, not extending to the costa, beyond the ocellus, which it does not touch.

Under surface more dusted with grey; only the outer transverse lines visible, which are brown, edged with bluish grey on the inside; the pink costal band of posterior wings above is replaced by a similar band on the inner margin of the anterior wings beneath. Anterior wings slightly falcate. Posterior wings long, slightly produced at anal angle.

Hab. Sierra Leone. Collected by Lieut. A. K. Slessar.

Evidently allied to *Buncea Jamesoni*, Druce, from the Congo; but the latter species seems to differ in the more distinct hyaline spot of the anterior wings and in the wings being much more suffused with purplish white, with the outer stripe of the anterior wings extending to the apex. In shape *B. rubricostalis* resembles *B. epithyrena*, Maass. It is closely allied to *G. obscura*, Butl., but differs in the red coloration, and in the shape of the posterior wings.

Automeris quadridentata. (Pl. XI. fig. 3.)

Exp. 110 millim.

♀. Brown, slightly inclining to reddish, especially on the thorax; abdomen indistinctly banded with brown; anterior wings with a short white stripe at the base in front, inner line at one third of the length of the wing much sinuated, hardly extending to the inner margin, and marked with yellowish white outside at each end and in the middle; costal spot large, its outline indicated by a pale line, slightly dentated and most distinct on the basal side; outside it is more dentated, and its course is marked by six black white-marked dots, the two innermost of which stand at the ends of the pale basal line. Outer line running from near the apex, which is moderately acute, to the middle of the inner margin; it is brown, slightly bordered with yellowish on the inner side, and marked with whiter dots on the nervures; from below the upper end of this line an obsolete festooned line runs slightly inwards to the inner margin, the space between this and the hind margin being a little lighter than the

ground-colour. Posterior wings greyer brown, with a large round black eye in a yellow ring (whitish outside) enclosing a large central space of a deep reddish-brown colour, crossed by a slender white crescent and bordered with yellow scales. This projects towards the middle of the inner margin in four sharp prongs. Beyond the ocellus is a festooned black line, beyond which is a broad reddish band, followed by a very pale pink border, only interrupted by a reddish line at the base of the fringes.

Underside paler; anterior wings with a large black central spot of an irregular roundish shape, followed by the outer oblique line, which is brown, broader than above, and interrupted by the yellowish nervures. Posterior wings with an irregularly festooned line at two thirds of their length, and faint traces of an outer one between this and the hind margin.

Hab. Brazil (*Becker*).

Intermediate between the groups represented by *A. nyctimene*, Latr., and *irene*, Cram.

EXPLANATION OF PLATE XI.

Fig. 1. Bunæa Mitfordi.

Fig. 2. Gonimbrasia rubricostalis.

Fig. 3. Automeris quadridentata.

XVIII.—*Supplementary Note on the Neuroptera of the Hawaiian Islands.* By ROBERT McLACHLAN, F.R.S. &c.

IN the Ann. & Mag. Nat. Hist. for October and November 1883 I published a list of the species of Neuroptera known to me from the Hawaiian Archipelago, chiefly compiled from materials collected by the Rev. T. Blackburn, who resided there for several years. This was followed, in the Ann. & Mag. Nat. Hist. for December 1884, by further notes and descriptions by Mr. Blackburn himself; the new species described in his paper remain unknown to me.

Recently I have been able to examine some small additional material collected by Mr. Scott B. Wilson, an ardent young ornithologist, who passed a considerable time in the islands. The few insects obtained by him are not in good condition; but as they include a new species of ant-lion, a family hitherto represented by a single species in the islands,

it appears to me well to notice them in the same publication, together with some memoranda made latterly.

The natural history, and especially the entomology, of the islands is just now being investigated by Mr. R. C. L. Perkins, under the auspices of a special committee; there can be little doubt that one result of his researches will be a large increase in the number of insects of all orders known to inhabit the islands.

ODONATA.

Subfam. LIBELLULINA.

Lepthemis Blackburni, McLach.

Lepthemis Blackburni, McLach. Annals, 1883, xii. p. 229.

Dr. F. Karsch (Berlin. entom. Zeitschr. 1889, p. 373) refers this to *Sympetrum*. If *Lepthemis* be practically limited to *vesciculosus*, F., and the rest of the species formerly placed therein be distributed in *Orthetrum* &c., I see no objection to considering *Blackburni* a *Sympetrum*; but I do not think it will eventually remain in this latter genus as exemplified by its well-known European representatives.

Deielia fasciata, Kirby.

Deielia fasciata, Kirby, Trans. Zool. Soc. Lond. xii. p. 380, pl. liii. fig. 6 (1889).

The type of this insect is identical with *Trithemis phaon*, forma dimorph. *dispar*, Selys, Ann. Soc. Ent. Belg. xxviii. p. 107 (1883), see also Compt. Rend. Ann. Soc. Belg. xxxii. p. lii (1888), as Mr. Kirby has himself since recognized according to the collection of the British Museum.

The point to be considered here is the locality of the type specimen, which was indicated as from the Sandwich Islands by Mr. Kirby and which bears a label "Sandw. Isld., Beechey." It thus becomes certain that the insect formed part of the collections made during the voyage of the "Blossom," but there is no means of tracing it more precisely. Neither Mr. Blackburn nor any other recent investigator of the Hawaiian Islands has noticed this conspicuous insect, and I feel grave doubts as to the correctness of the locality indicated on the British Museum specimen. *T. phaon* and its dimorphic female (*dispar*) have been found on the Chinese mainland, in Japan, and in the Loo-Choo Islands. The 'Blossom' visited the latter islands, and it is

not at all improbable that some confusion in the locality labels subsequently occurred.

That the insect is not a true *Trithemis* seems sufficiently certain. Kirby's genus *Deielia* may be retained for it at present, with a single species, as follows:—*Deielia phaon*, Selys, forma dimorph. ♀ *dispar*, Selys, = *fasciata*, Kirby. It may be that the form *dispar* is really the typical condition of the female; it is certainly the most abundant form in collections, and the band on the wings varies greatly, in some examples being reduced to vanishing point.

Subfam. *AGRIONINA*.

Megalagrion Blackburni, McLach.

Megalagrion Blackburni, McLach. l. c. p. 238.

The typical examples were from Maui. Mr. Wilson brought five males from Lanai which scarcely differ, the chief discrepancy being that the abdomen shows scarcely a trace of the narrow apical black ring on segments two to five which is conspicuous in the examples before me from Maui. This additional material proves, however, that the precise details of neurulation as regards what may be termed the supplementary rows of cellules are extremely unstable, differing slightly in each individual.

In addition to these Mr. Wilson brought one or two imperfect examples of an *Agrion* (?) of the *xanthomelas* group, peculiar to the islands; these specimens are too mutilated for identification.

NEUROPTERA-PLANIPENNIA.

Fam. *Myrmeleonidæ*.

Formicaleo Wilsoni, sp. n.

(Head and pronotum destroyed.) Meso- and metathorax and abdomen above and below dull leaden-black, without markings, but there are faint indications of a very narrow pale ring at the apex of the abdominal segments (end of abdomen destroyed); abdomen rather densely clothed with hairs, which are blackish above and hoary beneath. Legs: femora shining black, paler beneath, clothed with hoary hairs and furnished below with long and strong black spines; tibiae yellowish, with a black ring at the base and apex and another towards the base, the space between the latter and the apex spotted with black; spurs about as long as the first three

joints of the tarsi, testaceous, piceous at apex; tarsi black, the joints paler at the base beneath; claws testaceous, much curved.

Wings elongate, acute at the apex, which is slightly falcate in the posterior, about equal in length, hyaline; neuriation for the most part black, finely interrupted with yellowish-white on the subcosta and lower cubitus, and with similar but longer and fewer interruptions on the radius; the costal nervules mostly have a yellowish-white point in the middle (in anterior), and there are scattered nervules of the same colour over the disk of the wings; pterostigma inconspicuous, whitish yellow, with closely-placed thickish black nervules. In the anterior wings nearly all the nervules (except in the costal area) and the axillæ of the marginal and submarginal forks are clouded with blackish, giving the wings a strongly irrorated appearance; these cloudings are congested into a rather conspicuous spot at the termination of the branch of the lower cubitus on the inner margin, and there is a similar but smaller spot on the disk towards the apex on the line of the cubiti. In the posterior wings the cloudings are absent save on a few nervules round the apical portion and on the apical forks and those of the inner margin; a cubital spot on the disk before the apex as in anterior.

Expanse of wings about 85 millim.; greatest breadth of anterior $11\frac{1}{2}$ millim.

Hab. Lanai. Mr. Wilson brought one example.

The only species of *Myrmeleonidæ* otherwise known to exist in the Hawaiian Islands is *Fornicaleo perjurus*, Walker, a very much smaller insect (expanse about 60 millim.), without irrorated wings. Both, with other known species, belong to the group of *F. tetragrammicus*, F., of Europe and Asia.

XIX.—*Descriptions of Three new African Muridæ.*

By OLDFIELD THOMAS.

Mus (Dasymys) Bentleyæ, sp. n.

Closely allied to *M. (D.) incommutus*, Sund.*, of which a good description with figures has been published by Peters under the name of *Dasymys Gueinzii*†. Agreeing with that

* Gefv. Vet.-Ak. Förl. 1846, p. 120 (publ. 1847). Prof. Leche has kindly given me such information about the type of this species as has confirmed my supposition that *D. Gueinzii* was synonymous with it.

† MB. Ak. Berl. 1875, p. 12.

species in general form, the characters of its skull and teeth, and other essential points, but distinguished by its decidedly smaller size, smaller skull, and proportionally longer tail. Colour as in the figure of "*D. Gueinzii*." Ear large and broad, almost perfectly circular in outline; laid forward it falls about 2 millim. short of the posterior canthus of the eye. Posterior foot-pads six. Mammæ 1—2=6.

Dimensions of the type (an adult female in spirit):—

Head and body 128 millim.; tail 148; hind foot 30·5; ear, height above crown 15, breadth 17.

Skull: basal length 31·5, greatest breadth 18, nasal length 12·2; interorbital breadth 4; interparietal, length 3·8, breadth 9·2; nasal tip to back of interparietal 32·7; anterior zygoma-root 4·1; palate length 19·6; diastema 10·3; palatine foramina 8·1; length of upper molar series 6·5.

Hab. Ngombi (also called "Wathen"), Lower Congo.

Type B. M. 91. 2. 11. 2. Collected and presented, with many other interesting animals, by Mrs. Bentley, after whom I have great pleasure in naming it.

To this species I also assign two specimens obtained by Emin Pasha in Monbuttu, Central Africa, and referred by me in 1888* to *Mus Gueinzii*, although the peculiarity of finding a Natal species in Monbuttu was commented upon at the time. Since then, however, the Museum has received, through the kindness of Prof. du Bocage, two specimens of the Angolan species described in 1870† by Peters as *Mus nudipes*, a species described without any reference to the characters which made the same author erect *M. Gueinzii* into a separate genus, but one which proves to be so closely allied to this latter as to be very doubtfully separable specifically from it. Having this form now for comparison with *M. Bentleyæ*, and having also seen in the meantime the type of "*Dasymys Gueinzii*" in Berlin, I have changed my opinion about the Congo and Central-African species, and now consider it to be new.

The specimens of *nudipes* are remarkable for the entire suppression in them of the fifth hind foot-pad, while they are present in *M. Bentleyæ* and (*vide* Peters) in the Natal form. Were it not for this difference I should have little hesitation in uniting specifically the Natal and Angolan species, even though the latter appears to have slightly longer hind feet than the former.

* P. Z. S. 1868, p. 12.

† J. Sci. Lisb. 1870, p. 126.

Mus Daltoni, sp. n.

Size medium. Fur fairly long, rather coarse. General colour dull fulvous, not unlike that of many species of *Gerbillus*; darker along the centre of the back, clearer fawn along the sides. Chin, chest, and belly pure white, the hairs white to their roots. Ears large, rounded, thinly clothed with minute brownish hairs. Outer sides of limbs and wrists and ankles coloured like the back; inner sides and upper surfaces of hands and feet white. Pads large and rounded, those of the hind foot almost touching each other; distance from the front of the last hind pad to the heel equal to that from the same point to the tip of the second toe; the pad itself oval, but little longer than broad; hallux not reaching to the base of the second toe; fifth toe just to the end of the first phalanx of the fourth.

Tail about as long as the head and body combined, slender, finely scaled, greyish above, rather paler below, thinly covered with minute hairs, brown above and white below, which slightly increase in length at the tip. Mammæ 3—2=10.

Skull with a narrow delicate muzzle; interorbital region flat, its edges square and slightly thickened, but without raised ridges; plate of anterior zygoma-root evenly convex forward; palatine foramina ending level with the anterior laminae of \underline{m}^1 ; bullæ rather small. Molars small and narrow.

Dimensions of the type (B. M. 65. 3. 30. 6), a female specimen preserved as a skin:—

Head and body 117 millim.; tail 114; hind foot 19.2; heel to front of last foot-pad 9.1; ear 15.

Skull: tip of nasals to lambda 23.3; greatest breadth 13.6; nasals, length 11.6, greatest breadth 3.2; distance between outer corners of infraorbital foramina 7.0; interorbital breadth 4.2; length of anterior zygoma-root 3.3; palate length 14.1, breadth outside \underline{m}^1 5.8, inside \underline{m}^1 3.4; diastema 8.0; anterior palatine foramina 6.4; length of upper molar series 4.2.

Hab. W. Africa (probably Fernando Po). Collected by Mr. J. T. Dalton.

This species belongs to the group characterized by the possession of 3—2=10 mammæ and by their otherwise general resemblance to the multimammate African species. To this group should be referred *M. albipes*, Rüpp., *M. colonus*, Brants, and *M. angolensis*, Boc.; but all these are decidedly larger than *M. Daltoni* and all have grey-based instead of pure white belly-hairs.

A second specimen obtained from Mr. Dalton at the same time as the type agrees with it in every respect.

Mus Burtoni, sp. n.

Size rather small, form slender and delicate. General colour a soft greyish rufous, smooth, scarcely grizzled, darker along the middle of the back, paler on the sides, the general tone not unlike that of *Mus sylvaticus*. Belly-hairs grey basally, pure white terminally, the line of demarcation on the sides not sharply marked. Ears rounded, laid forward they reach just beyond the centre of the eye; slaty grey in colour, thinly clothed with very sparse fine hairs, so minute that the ear as a whole looks quite naked. Hands and feet whitish, the dark colour of the body not encroaching on the metapodials; pads as usual 5-6, smooth, rounded, well defined; palms and soles quite naked, the skin perfectly smooth between the pads; pads at bases of first and fifth hind digits each with a small supplementary external pad. Hallux reaching to the base of the second digit, fifth toe to the distal end of the first phalanx of the fourth. Tail longer than head and body, very slender, pale slate-coloured above, scarcely lighter below, thinly haired, the hairs not hiding the scales; scales very small, the rings numbering about seventeen to the centimetre. Mammæ 1-2=6.

Skull.—Upper profile evenly but decidedly convex. Interorbital region broad and smooth, its edges sharply square, but without upwardly projecting ridges; posterior part of frontal embraced laterally by two slender arms of the parietals, which run forwards close to the supraorbital edges. Interparietal large, its antero-posterior diameter fully or slightly more than half its transverse diameter. Anterior zygoma-root short, its anterior edge evenly convex forward. Diastema very long, owing to the small size of the molars. Anterior palatine foramina ending just in front of the level of the root of m^1 . Bullæ small, little swollen.

Teeth.—Incisors orange above, rather paler below. Molars excessively small, their combined length less than half the diastema; their surfaces too much worn in the type for description, but their structure is apparently similar to that found in the small-toothed African species, such as *M. albipes* or *M. coucha*; m^2 with the usual antero-internal but no antero-external secondary cusp.

Dimensions of the type (an adult or even aged female in alcohol):—

Head and body 108 millim.; tail 133; hind foot 22; heel to front of last foot-pad 10; ear, above crown, 13·5.

Skull: nasal tip to back of interparietal 32·3; greatest breadth 15; nasals, length 12·2, breadth 4; interorbital

breadth 5·7; interparietal, length 5·2, breadth 9·6; length of anterior zygoma-root 4; palate length 17·8; diastema 9·8; length of upper molar-series 4·7; breadth of \overline{m}^1 1·4; breadth of palate inside \overline{m}^1 (c.) 3·3.

Hab. Ankober River, Wasa, Ashantee.

The type specimen (B. M. 82. 6. 12. 5) of this beautiful and interesting little species was obtained by the well-known explorers Capt. (later Sir Richard) Burton (after whom I have named it) and Lieut. V. Lovett Cameron, during an expedition to the Gold Coast in 1882.

The only species with which the present one could be confounded is *Mus erythroleucus*, Temm., and that only because its mammary formula and detailed characters have not hitherto been published. Thanks, however, to the kindness of Dr. Jentink, of the Leyden Museum, I have had the opportunity of examining the type and of directly comparing its skull with some of the Museum specimens. This type I have been able to match in every respect with some spirit specimens from Akropong, on the Gold Coast, presented to us by Prof. Rutimeyer in 1886. These show that *M. erythroleucus* is one of the multimammate species allied to *M. natalensis*, *coucha*, &c., and that it has, as is indeed shown by the type itself, a hallux which falls far short of the base of the second toe and a fifth hind toe that only just attains to the base of the fourth; the tail also is slightly shorter than the head and body.

XX.—On the Japanese Cleridæ.

By G. LEWIS, F.L.S.

THE list of species in the family Cleridæ I am able to give from Japan is not a long one, and it seems probable that my acquisitions in the family exhibit my collection in its weakest part. Some of the species obtained were apparently very local, and only three of the genera, leaving out *Necrobia*, contain more than one species; and this is a condition of things not likely to be maintained in any tropical or subtropical fauna. There is evidence also that the abodes of some of the species are in the highest branches of the decaying forest-trees, whose leafless and partly barkless limbs stretch out above the foliage of the accessible brushwood. These of course are difficult to obtain, and it is only the detached single examples from such places that the collector fortuitously sweeps into a net from the lower foliage.

The Cleridæ also in the adult stage are, like the Erotylidæ and other families, very short-lived, and it is not often an entomologist happens to be near their centre of emergence at the opportune moment. Two such chances, however, occurred to me in Japan. Once I saw *Tillus* in profusion at Nagasaki on some brushes covered with blight; but whether they were attracted by the larvæ of *Coccinella*, which came also, or by the Aphidæ I am unable to say. At another time I saw *Stigmatium* in similar plenty, feeding on a species of *Tomicus* which was busy drilling holes in the stems of a dead and tangled mass of the *Wistaria*. The Cleridæ as a family are predaceous.

For the convenience of students of the Japanese fauna I have divided the species into two sections, which seems from the material in hand to be a natural division, as each one possesses conspicuous characteristics in tarsal structure and dorsal punctuation. I have also been obliged, somewhat unwillingly, to establish several new genera.

List of Species, arranged generically.

| | |
|--|--------------------------------------|
| <i>Spinoza cærulea.</i> | <i>Necrobia ruficollis, F.</i> |
| <i>Tillus notatus, Klug.</i> | <i>Corynetes cæruleus, De Geer.</i> |
| <i>Cladiscus obeliscus.</i> | <i>Opetiopalpus morulus, Kiesew.</i> |
| <i>Opilo carinatus.</i> | <i>Tenerus cyaneus.</i> |
| —— <i>niponicus.</i> | —— <i>maculicollis.</i> |
| <i>Thanasimus nigricollis.</i> | —— <i>higonius.</i> |
| —— <i>albomaculatus.</i> | —— <i>Hilleri, Harold.</i> |
| <i>Omadius nigromaculatus.</i> | <i>Thaneroclerus aino.</i> |
| <i>Stigmatium pilosellum, Kiesew.</i> | <i>Neoclerus ornatulus.</i> |
| <i>Tarsostenus univittatus, Rossi.</i> | <i>Isoclerus pictus.</i> |
| <i>Necrobia rufipes, De Geer.</i> | <i>Lyctosoma parallelum.</i> |
| —— <i>violaceus, L.</i> | |

The fifteen species which are given precedence in this paper have the punctuation of the elytra arranged in longitudinal lines, and all the tarsal joints are more or less elongate.

SPINOZA, gen. nov.

Cylindrical; head subtransverse, less in width than the thorax; eyes prominent, coarsely granulate, circular in outline; palpi, last joint greatly enlarged, flat on either surface, lobe-shaped. Antennæ, first joint bulbiform anteriorly, constricted at base; second smaller and shorter, not constricted; third rather elongate-cylindrical; fourth and fifth stouter and together measuring slightly more than the third; sixth to eighth moniliform and coequal; ninth to eleventh form a lax club; terminal joint oval. Tarsi rather long and in size equal on each tibia; claws with a strong interior process stouter and nearly as long as the claw itself. The elytra are nearly

four times the length and as wide again as the thorax, and have ten striæ composed of regular punctures.

This genus may be placed close to *Cymatodera*, and it has been named after Baruch de Spinoza.

Spinoza cærulea, sp. n.

Cylindrica, hirsuta, subcærulea, nitida; elytris fortiter striato-punctatis; antennis pedibusque corpore concoloribus.

L. $5\frac{1}{2}$ mill.

Head shining, very sparsely punctured, with two shallow foveæ between the eyes; the thorax is clothed with long greyish hairs, little uneven and nearly impunctate, slightly constricted at the sides behind the coxæ. The elytra are clothed with similar hairs; the punctures consist of ten rows, clear and regular at the bases, somewhat evanescent towards and at the apices. The claws and their inner processes are pale.

Hab. Main island; Kashiwagi, June 15th, 1881.

Tillus notatus, Klug, 1842.

Tillus Lewisii, Kiesenw. 1879.

Hab. Kiushiu.

This is the species spoken of in the preamble; and Mr. Gorham, having lately examined a series with many varieties from Assam and Burma, has been able to settle the synonymy for me, and has kindly done so.

Uladiscus obeliscus, sp. n.

Cylindricus, parallelus: capite elytrisq̄ue totis nigris; thorace rufo.

L. $6-7\frac{1}{2}$ mill.

Cylindrical, parallel; the antennæ black, with two basal joints usually red; the last are cylindrical; joints 4-10 are triangular, being slightly dilated on the inner edge; the head wider than the thorax, sparsely punctulate, eyes prominent; the thorax widest behind the neck, very much constricted behind the coxæ, punctured like the head; the elytra strongly punctate-striate for three quarters of their length, punctures then abruptly evanescent to the apex; the legs are black, with the claws infusate; the anterior and intermediate coxæ red.

The species was formerly assigned by Kiesenwetter to *C. strangulatus*, Chev., an insect from the Philippine Islands; but Chevrolat's species has pectinated joints in the antennæ, while in *C. obeliscus* the corresponding joints are

simply triangulate in both sexes. In colour the species are similar.

Hab. Kiushiu and main island. This insect appears towards the end of July. Nagasaki, Maiyasan near Kobé, and Fukushima are special localities for it.

Opilo carinatus, sp. n.

Elongatus, rufo-brunneus, pubescens; capite rugose punctato; thorace in medio carinato; elytris striato-punctatis, in medio obscure luteo-fasciatis.

L. 12-13 mill.

Elongate, reddish brown, the head impressed between the eyes, rugosely, rather coarsely, and densely punctate; the thorax similarly punctured, with a depression in the middle; the centre of the depression has a smooth longitudinal carina; the elytra are distinctly striate-punctate, with apex, median fascia, and humeral angles pale; the dark portion, which corresponds to the darkened disk in the next species, is strongly produced anteriorly between the second and third striæ from the suture, and also posteriorly along the edges of the suture.

Hab. Kiushiu. I obtained this species in the southern island only.

Opilo niponicus, sp. n.

Elongatus, rufo-brunneus, pubescens; antennis pedibusque corpore concoloribus; capite tenuiter punctato; elytris striato-punctatis vel obsolete punctatis.

L. 9-11 mill.

Elongate, reddish brown, little shining; the head and thorax lightly and somewhat rugosely punctured, feebly impressed in the centre; the elytra somewhat faintly striate-punctate at the base, the striæ being evanescent for one third of the wing before the apex (in some specimens the striæ are obsolete throughout). The colour of the elytra is very variable; the pattern is never defined as in *O. mollis*, L., but usually there is a dark sutural disk before the apex, and two pale marks in front of it on each elytron placed longitudinally near the suture; the apex is always broadly pale.

The more important differences between this species and *O. mollis*, L., are that the thorax is much less punctate, the antennæ longer, with the club more lax, and the elytral striæ much less defined, while the pattern formed by the coloration is very variable and often diffused.

Hab. In the northern islands.

Thanasimus nigricollis, sp. n.

Elongatus, niger, cinereo-pilosus, nitidus; elytris basali late rufis, postice fasciis duabus albis; abdomine rufo; antennis pedibusque nigris.

L. 8-9 mill.

T. nigricollis is in many respects similar to *T. formicarius*, L. The points of difference are that it is larger, with much longer tarsi, head and thorax more robust and more lightly and less thickly punctured, with the anterior portion of the thorax much wider. The elytra also are red to nearly one third of their length, and are then crossed with a very narrow white band; the dorsal black band is wider and the abdomen a clear red.

Hab. All the islands. Under pine-bark on Oyayama, Omine, Nantaisan at high altitudes, and at Sapporo at about sea-level.

Thanasimus albomaculatus, sp. n.

Elongatus, niger, hirsutus, nitidus; elytris griseo-pilosis, prope basin et pone medium albo subrecto-fasciatis; antennis articulis 1^o-6^m rufis; pedibus piceis.

L. 3½ mill.

This small species is very similar to *T. anthicoides*, Westw., figured in the Proc. Zool. Soc. 1852, but it is larger and the antennæ are relatively longer; the two basal fasciæ are more transverse. The head and thorax are clothed with black, and the elytra with grey, hairs; the first six joints of the antennæ are red, the others black except the apex of the last joint, which is pale.

I found a similar species to the above in Ceylon, and I think it and the above with *T. anthicoides*, Westw., might be separated generically from *Thanasimus*; but as I am only studying the family from a faunistic standpoint, I have left this to be done if necessary by a future monographer of the family.

Hab. Kiushiu. I obtained four examples in Higo.

Omadius nigromaculatus, sp. n.

Infuscatus, dense griseo-pilosus; elytris nigro-maculatis; abdomine rufo; antennis (basi excepta) nigris, tarsis rufo-brunneis.

L. 11-12 mill.

Infusate, densely pilose, pile generally grey, but golden between the eyes; the two basal joints of the antennæ are pale, the rest nearly black; the thorax dark and immaculate; the elytra, basal half or nearly half grey, with two black

being sometimes confluent with an epipleural black patch ; behind the grey area is a broad, densely black band, which is followed by an apical grey area, in the centre of which are two well-defined black spots, one in the middle of each elytron. The legs vary in colour, but the tarsi are reddish brown and the fore legs generally palish with their upper edge blackish ; the abdomen wholly reddish brown.

This species closely approaches *O. nigropunctatus*, Chevrr., in many of its characters.

Hab. Kiushiu. Six examples in Higo ; and I have little doubt but that it occurs only in the subtropical portions of Japan.

Stigmatium pilosellum.

Clerus pilosellus, Kiesenw. 1879, = *Thanasimus pilosellus*, Gorham, 1878.

The species is a typical *Stigmatium*.

Hab. Kiushiu, at Nagasaki and Konose.

Tarsostenus univittatus, Rossi.

Hab. Kiushiu. I observed this insect once in abundance on the rafters of an old cottage at Ipongi, near Nagasaki. I believe this species has only been recorded from Europe until recent years ; but there are specimens in the Museum from Natal, Ceylon, and South Australia.

Necrobia rufipes, De Geer.

Hab. Kiushiu. A single example was found in carrion at Nagasaki.

Necrobia violaceus, L.

Hab. All the islands.

Necrobia ruficollis, F.

Hab. Frequent in all the towns and in the larders of steamers calling at the ports.

Corynetes cæruleus, De Geer.

Hab. Generally distributed in all the islands.

Opetiopalpus morulus, Kiesenw.

This insect is more parallel than *obesus*, White, and the head is narrower and more deeply punctured and is black. The antennæ also are only red at the base. I have placed an example by the side of White's type in the Museum.

Hab. Kiushiu. At Ipongi, near Nagasaki, by beating the thatch on old cottages in June and July.

In the eight species which follow the punctuation of the elytra is thickset, without lineal arrangement, and the basal joints of the fore tarsi are short and transverse, except in the genus *Tenerus*.

Tenerus cyaneus, sp. n.

Angustatus, cyaneus, griseo-pubescent; antennis nigris; pedibus infuscatis.

L. $5\frac{1}{2}$ mill.

This species is narrower than *maculicollis*, Lew., and is wholly blue above and beneath; but in its general sculpture I cannot find much to distinguish it.

Hab. Kiushiu. Konose, in Higo, one example only.

Tenerus maculicollis, sp. n.

Rufo-testaceus, pubescens; thorace in medio nigro-maculato; elytris griseo-pubescentibus, cyaneis; antennis (basi excepta) nigris; pedibus rufis; metasterno abdomineque infuscatis.

L. 5-6 mill.

Head and thorax clothed with reddish pubescence, red, with the thoracic disk black; the black disk in one example is enlarged before and behind; the elytra are cyaneous, clothed with grey pubescence, more rugosely punctate at the base than at the apex; antennæ, basal joint red, the rest black; the metasternum and the last four segments of the abdomen are infuscate; legs wholly red. Scutellum blue.

This species is smaller than *higonius* and has an important specific character in the colour of its pubescence.

Hab. Kiushiu. Taken at Yuyama, in Higo.

Tenerus higonius, sp. n.

Robustus, rufo-testaceus; antennis nigris; elytris cyaneis nigro-pubescentibus; scutello, antennis pedibusque rufis.

L. $8\frac{1}{2}$ mill.

Much more robust than the preceding species, but in some respects very similar. Head, thorax, legs, and under surface red, except the last three segments of the abdomen, which are blackish; scutellum and basal joint of the antenna red.

The punctuation in the species of this genus does not seem to serve for specific characters, but the colours in the Japanese species seem to be fairly constant.

Hab. Kiushiu, at Yuyama.

Tenerus Hilleri, Harold.

Tenerus Hilleri, Harold, Deutsch. ent. Zeitschr. 1877, p. 357.

Hab. Main island. Taken by Herr Hiller at Hagi, in Yamaguchi.

Thaneroclerus aino, sp. n.

Brunneus, pilosus, vix nitidus; antennis, palpis pedibusque corpore concoloribus; capite thoraceque dense punctatis.

L. $5\frac{1}{2}$ –6 mill.

There are two specimens of a species of this genus in the Museum from Bombay which I consider represent *T. Buqueti*, Lefebvre, and the Japanese species differs from them as follows:—The head is smaller, the thorax more constricted behind, the antennæ very much stouter, club less lax, claws stouter, and the punctuation of the head and thorax is closer and larger, giving an appearance of greater opacity. The punctuation of the elytra is somewhat large and close from the bases to the middle of the dorsal region; towards the apices it becomes smaller and a little scattered, especially near the suture.

Hab. Yezo. Two examples from Junsai, near Hakodate.

NEOCLERUS, gen. nov.

The species of this genus have a similar outline to those of *Thaneroclerus*, but the tarsi and antennæ are very differently constructed, and they are brightly coloured or prettily marked. The head is less wide than the thorax; eyes coarsely granulate, lobe-shaped; palpi short and not dilated; antennæ, first joint somewhat bulbiform anteriorly, base constricted, second to fourth nearly coequal, fifth to eighth moniliform, ninth twice the width of eighth, tenth and eleventh nearly equal in size and form an oval club (in an undescribed Ceylonese species the club is a little lax); the thorax moderately constricted behind the middle; the thighs robust, anterior tarsi with basal joints very short and conspicuously dilated.

Neoclerus ornatulus, sp. n.

Rufo-brunneus, hirsutus; capite thoraceque supra nigris; elytris coccineis, regione scutellari maculisque utrinque duabus nigris; antennis pedibusque rufo-brunneis.

L. $3\frac{3}{4}$ –4 $\frac{1}{2}$ mill.

Reddish brown beneath, with legs, palpi, and antennæ con-

colourous; above, head between the eyes, thorax except the anterior margin, and three large spots on each elytron black. The elytra are very bright red, with two semicircular spots at the base behind the scutellum, each one touching the suture; in the middle of the dorsal region are two lobe-shaped spots, each one longer than the two scutellar spots together, well separated at the suture, but externally leave the epipleura alone red; the two posterior black spots are well before the apex, and more transverse than the dorsal pair, and leave only a narrow division of red at the suture.

Hab. Kiushiu, and on the main island. Oyayama, Iken-chaiya, and Nikko, five or six examples.

ISOCLERUS, gen. nov.

Body with an outline resembling *Thanasimus*, but the tarsi agree closely with those of *Thaneroclerus*. The eyes are coarsely granulate, rather prominent, and anteriorly semicircular in outline; the posterior part, which is in some genera cut out, is nearly straight, but the contiguous part of the head is swollen and convex, so that the limit of the eye is only indicated by its granulations. Antennæ, first joint bulbiform, with a short funicle; second and third of equal length, constricted slightly in the basal half; fourth to eighth shorter and moniliform; ninth to eleventh form a lax club; ninth and tenth are equal to each other in length and breadth, the terminal joint being conical and nearly as long as the two preceding joints; femora short and robust, the basal joints of the anterior tarsi are conspicuously dilated and short, claws simple.

Isoclerus pictus, sp. n.

Rufobrunneus, sparse hirsutus; capite antennisque (basi excepta) nigris; thorace rufo; elytris regione scutellari, macula humerali, fasciis mediis et posticis late nigris; pedibus rufis.

L. $3\frac{3}{4}$ mill.

Elongate, hirsute, rather shining; the head black, rather thickly and somewhat coarsely punctured; the antennæ, two basal joints red, the rest infuscate; the thorax red, with the margin behind the neck black, punctured like the head; the elytra more coarsely punctured than the thorax, black, with two pale fasciæ, one before, the other behind the middle; the first is narrowly connected with humeral angle, which is also pale; this leaves a large circular spot round the scutellum and a

marginal spot black; the second is transverse and very slightly oblique; the legs and tarsi are wholly red.

There is a variety with red antennæ, the thorax wholly red and having the elytral marginal spot obliterated, leaving the space behind the humeral angle pale.

Hab. Main island. Found at Nikko and Chiuzenji in June 1880.

LYCTOSOMA, gen. nov.

Head half the length of the thorax, rounded off at the sides; the eyes small and little prominent, coarsely granulate, semicircular in front, feebly emarginate behind; palpi fusiform. Antennæ half as long again as the head; first joint bulbiform, with an inconspicuous funicle; second stouter and round, breadth equal to length; third to fifth longer and not so robust; sixth to eighth moniliform; ninth to eleventh form a lax club, terminal joint being longer than the tenth and of a short oval form. Thorax parallel at the sides, gradually rounded off behind and before; elytra parallel until just before the apex; the thighs rather robust, anterior tarsi short and transverse, claws with a small inconspicuous process near the base.

This genus may be placed near *Thaneroclerus*, on account of the structure of the antennæ, legs, and tarsi. The species has a certain resemblance to a small specimen of *Lyctus brunneus*, Steph.

Lyctosoma parallelum, sp. n.

Elongatum, parallelum, ferrugineum: antennis pedibusque corpore concoloribus.

L. 3 mill.

Elongate, parallel, wholly ferrugineous, sparingly hirsute; the head sparsely covered with somewhat acicular punctures; the thorax more thickly punctured, punctures oval; the elytra with punctures less deep and more round, but of similar density.

Hab. Kiushiu. Two examples came from under bark near the temple of Suwoyama, at Nagasaki, in the spring of 1881.

A curious species, which I consider belongs to the Telephoridæ, has been described by me and assigned to the genus *Sisynophorus* (Ent. Month. Mag. 1891, p. 210), but perhaps later it will be well to make a new genus for it. I make a note of it here, as some of its allies have been included in the Cleridæ.

XXI.—*Description of a new Species of Ornithoptera, of the Priamus Group, in the Collection of the Hon. L. Walter Rothschild.* By ROBERT H. F. RIPPON.

Ornithoptera eumæus, sp. n.

♂. Wings silky green-blue (nearly peacock-blue), especially the primaries, in some lights a blue-green; narrowly bordered with black. Primaries on the upper surface with a broad, costal, longitudinal, discal band of nearly uniform width extending from the base to within a few millimetres of the apex, slightly narrower at each extremity, strongly divided from the base by the costal and subcostal nervures, and again nearly midway by the subcostal nervure and its first branch nearest the costa; this band broadens slightly and irregularly where it meets the first or upper discocellular nervule; the sexual transverse velvety patch extends from the first median nervule to midway of the space bounded by the median and subcostal nervures, is not separated from the green-blue by black, and is of a rich dark fuscous; the median nervure nearly to the base strongly accentuated by green-blue atoms, its three branches and the third or lower discocellular nervule being also dusted in the same manner, the atoms of the first median branch extending into the coloured border; all the remaining nervures and their branches are indicated faintly by these atoms; a green-blue marginal band extends from the base of the posterior to four fifths of the exterior margin, narrowest at the base and towards the anterior angle, where it becomes divided by the marginal folds into two or three elegantly curved patches, decreasing in size towards the outer angle, following the outline of the margin of the wing; all the remainder of the wing a deep velvety blue-black.

Underside a rich black, becoming very tawny black towards the exterior margin, the neurulation standing well in relief in either black or tawny black; within the discoidal cell an elongated patch of bluish green two thirds of its width near the discocellular nervules and very narrow at the base; a slight irregular margin of the same colour also at the upper part of the cell close upon the subcostal nervure; a few atoms also are so arranged as to suggest that the tendency was for the whole cell to be filled with green; without the cell the disk contains six green patches, widely separated by the nervules, and two costal patches, bounded by the third and fifth subcostal branches, the uppermost being the

largest, and each of them being rather a congeries of more or less densely sprinkled atoms than a continuous patch of green; the first four of these, starting from the posterior portion of the wing, are divided nearest to the outer margin by a more or less sublunate black spot; the fifth contains a triangulate, indented, and the sixth an elongate mark; all the green patches are well separated from the neuration by black and from the exterior margin of the wing by tawny black.

Secondaries: a silky green-blue extending over the wing till just within the second subcostal nervure, when the colour abruptly becomes a rich green, somewhat like that of *O. aruana* (Felder); this fills the remaining space of wing to the anterior margin, but is not found within the discoidal cell; the green and green-blue are delicately dusted and gradated by black atoms outwards from the base and downwards; three black submarginal ovoid spots, the first within the first and second subcostal nervules twice the length of the third and less distinct, being dusted with green atoms; the outer margin of the wing narrowly black, the median and subcostal nervure and first subcostal branch black and well-defined in the green; the space within the precostal nervure to the base brown-black. Underside rich golden-green, as in *aruana*; the space from the anal angle within the submedian nervure and third median nervule halfway up golden-yellow, base black; six large submarginal black spots, the upper one quadrate, the others more or less suboval; anterior margin partly filled with green, and space on each side of pre-costal nervure with green atoms; exterior black margin slightly broader than on the upperside, indented inwardly within the first and second subcostal and second subcostal and discoidal branches; the subcostal nervure and its first branch well defined by black.

Head.—Eyes pearly light brown, margined with white; space between deep black; antennæ light smoky brown.

Thorax.—Velvety black, with a very obtrusive longitudinal green-blue stripe; beneath lateral red patches and tawny black. Legs black.

Abdomen.—Golden yellow and ferruginous brown, the latter perhaps intensified by fading; anal segment with the usual trisinate black mark and a minute tawny curved spot on each valve divested of scales; lateral black dots six in number.

Length of costa 80 millim.; antennæ and abdomen each 33 millim.; head and thorax about 20 or 22 millim.

Hab. Aru Islands.

On the underside this form does not present any features sufficiently distinct to distinguish it from *aruana*; the upper surfaces, however, are remarkably different in colour from that species, though the arrangement of the markings is nearly the same. The rich golden-green of *aruana* is replaced in this species by the brilliant green-blue, and the singular patch of vegetable- or *aruana*-green on the posterior wing, as described above. By contrast with the green-blue this colour seems most like that of *pegasus* (Felder), while the gradations of colour and opalescent tints in certain lights link it with *Urvilliania* and *cræsus* on the one hand and *priamus* and *pronomus* on the other. Possibly it is only a remarkable transitional variety of *aruana*, but at present it is sufficiently distinct to merit a distinguishing name; and it goes far towards enabling us to link together the whole of the members of the *priamus*-group and regard them as local forms of the typical species *priamus*.

♀. Wings on both surfaces tawny brown, richer on the underside. Primaries with a subquadrate oblique patch within the discoidal cell sordid white, the *pseudoneura* quite visible; without the cell are eight elongate separated marks of the same colour, the first within the third and fourth subcostal branches ill-defined in outline, short and acuminate, the second shorter and broader, the third a long hastate mark filling one half the space between the nervules and containing a cuneiform spot; the fourth is shorter, with a larger cuneiform spot; the fifth consists of three white spots of different forms, widely separated by the brown; the sixth is divided into two of unequal size; the seventh is divided into a long hastate and an irregular-shaped small mark; the eighth is twin-spotted, with a faint spot higher up; the exterior margin with small whitish scalloped spots. The sordid colour is caused by the white being all covered with grey scales. Secondaries with the submarginal band white and very broad, occupying the greater part of the disk between the nervules; four divisions, or those bounded by the second subcostal and the third median branches, containing midway a moderately-sized orbicular tawny brown spot, the upper one being the largest; each of these divisions is sinuate at the outer end, the indentations being most numerous in the upper two, and all are pointed or acuminate at the ends nearest the cell. Between the first and second subcostal nervules is a separated sinuate spot or a portion of the white band cut off by the brown of the wing; below the black orbicular spots the white becomes more tawny, and between each of the divisions are indications in

ochre of the trigonal yellow marks of the underside; the lunations of the outer margin tawny yellow-white.

The undersides of the primaries differ little from the upper; the same may be said for the secondaries, except that between the costal nervure and the first subcostal branch is a small dark yellow irregular-shaped spot; a small orbicular black spot in the white between the submedian nervure and the third median branch, and the white beneath all the black orbicular spots contains a yellow acuminate mark filling most of the space from the spot to the sinuate border, the lunations of the exterior margin being also yellow; neuration well defined above the black.

Head.—Eyes dark brown, margined with tawny white.

Thorax.—Above tawny brown, with a narrow green-ochreous longitudinal stripe; beneath, lateral crimson-scarlet spots occupying much of the space above and on each side of the legs, the remainder tawny brown.

Abdomen.—Above greenish-ochreous white; subdorsal brownish ochreous-yellow, with strong black articulations and five lateral black dots.

Length of costa 102 millim.; antennæ and abdomen each 37 millim.; head and thorax 25 millim.

From the foregoing it would appear that the pattern is of the same type and well within the limits of the variations in the species *aruana*; and this insect might well be taken as a female var. of that species. In the case of the male it would be impossible to make a mistake.

Hab. Aru Islands.

This species will be fully figured in the fifth part of the author's 'Icones Ornithopterorum.'

MISCELLANEOUS.

Diagnosis of a new Mexican Geomys. By OLDFIELD THOMAS.

Geomys Bulleri, sp. n.

Apparently allied to *G. castanops*, LeC., but smaller, with a naked tail, and with the face more slaty than the body instead of more chestnut, and with white hairs bordering the naked nasal pad.

Dimensions of type (♀ in spirit):—Head and body 135 millim., tail 63, fore foot and claws 27·5; hind foot 25·5, with claw 27·6. Skull of a second specimen (♂), basal length 33·4.

Hab. Talpa, Mascota, Jalisco, 8500 feet (*Dr. A. C. Buller*).

The History of the Freshwater Nemerteans; their Geographical Distribution and their Origin. By M. JULES DE GUERNE.

A learned Swiss naturalist, Dr. du Plessis, recently announced, in one of the most widely circulating zoological journals *, that he had just made a *very surprising discovery*. On the 29th of October, 1891, a Nemertean had been found by him on the shores of the Lake of Geneva. "*The presence of this marine worm was so improbable,*" says the author, "*that we could not believe our eyes.*"

However curious the fact mentioned by Dr. du Plessis may appear, it is nevertheless not new. Nemerteans have been observed in fresh water sufficiently often that their existence out of the sea ought nowadays to be no longer a matter of great surprise †. Prof. Vaillant has already reminded us, in the very periodical in which Dr. du Plessis's article appeared, of several analogous cases which have been known for a very long time ‡.

In reverting to the question myself I do so in the first place in order to supplement M. Vaillant's note, in which divers remarkable cases seem to have been overlooked, and secondly and in particular in order to call the attention of French naturalists to the freshwater Nemerteans which may very well happen to come into their hands.

As a matter of fact these animals were discovered in France, in the neighbourhood of Montpellier, by Dugès, who described and figured them as early as 1828 §.

Prof. Vaillant appears to have met with these worms once more in the same region some fifteen years ago ||. However, since he did not study them in any way, and the writings of Dugès, which are already antiquated, are very incomplete, there remains some doubt as to the value and identity of the species.

Be that as it may, the first precise statements as to a freshwater Nemertean were made in 1847 by de Quatrefages, who called the creature *Polia Dugesii*. The animal actually occurred in Paris, in the Saint-Martin Canal, and if we can hardly hope to rediscover it in this medium, which is nowadays polluted by all sorts of impurities, we can at any rate look for it in certain more limpid waters of the basin of the Seine. Three figures accompany the description of *Polia Dugesii*, the discovery of which certainly passed unnoticed owing to its being published in the '*Recherches anatomiques et zoologiques faites pendant un voyage sur les côtes de Sicile*' ¶.

* '*Zoologischer Anzeiger*,' Bd. xv. no. 384, Feb. 15, 1892.

† The small size of the animals is probably one of the reasons which prevents their being recognized. They are filiform, and scarcely exceed 15 millim. in length when extended.

‡ *Zool. Anzeiger*, Bd. xv. no. 387, March 28, 1892.

§ *Ann. des Sc. nat.* vol. xv. (1828), and vol. xxi. (1830). Dugès created for these worms the genus *Prostoma*, the type of which is *P. clesinoides*, found in running water under stones (1828). Later on three other species (*P. lumbricoideum*, *P. candidum*, and *P. armatum*) were added. Of the latter the first alone is fluviatile; the two others were found on the shores of the Mediterranean (1830).

|| *Hist. nat. des Annelés mar. et d'eau douce*, vol. iii. (1889).

¶ 2^e partie, note on page 211, in the explanation of the plates. The figures concerning *Polia Dugesii* are to be found in pl. xiii. under the

Thus no allusion was made to it four years afterwards by Max Schultze, who, on the authority of F. Müller, mentions the occurrence of one of Dugès's species at Berlin. At the same time another freshwater Nemertean, belonging to an undetermined species, was reported from a peat-bog at Greifswald*.

During this time a freshwater Nemertean was described by Leidy in an incomplete fashion from the United States; this animal was found in the environs of Philadelphia, and was named *Enea rubra* †. It was for the same worm that Diesing, in 1862, created the family Emeidæ, without, however, having observed the animals which he assigned to it ‡.

Shortly before the appearance of Diesing's paper Prof. Schmarda had described, under the name *Nemertes polyhopla*, a new Nemertean from the Lake of Nicaragua, which appears in all probability to belong to a different type from that of all those with which we have been dealing §.

For some ten years from that time no naturalist seems to have met with any freshwater Nemerteans. In 1869 Czerniavsky, a Russian zoologist, mentioned the existence of an entire fauna, and especially Nemerteans, of a marine character in the fresh (or, at least, potable) waters of Lake Paleostom, situated on the eastern shore of the Black Sea. Shortly afterwards, in 1872, Fedtschenko published an interesting study upon a *Tetrastemma* found by him in the neighbourhood of Tashkend, in Turkestan, and which he called *Tetrastemma turanicum*. Fedtschenko, who was well acquainted with the researches of his predecessors, unhappily, like Czerniavsky, wrote his memoir in Russian, which has led to its being neglected by almost every one, although it is accompanied by a plate ¶.

After this, the first paper in which we once more find mention of a freshwater Nemertean appeared in 1884*-. In the article in question W. A. Silliman deals (under the name *Tetrastemma aquarum dulcium*) with a worm which is of universal distribution, although always in small numbers, in the county of Monroe (New York

* 'Beiträge zur Naturgeschichte der Turbellarien,' 1851.

† Proc. Acad. Nat. Sci. Philadelphia, vol. v., Dec. 1850 and Oct. 1851.

‡ Sitzungsber. k.-k. Akad. Wiss. Wien, math.-naturw. Cl., Bd. xlv. (1862).

§ 'Neue Turbellarien, Rotatorien,' &c., Bd. i. Heft i. (1859). The great lake of Nicaragua (Cocibulco), whose waters, which are entirely sweet, embrace an area of more than 3476 square miles ("plus de 9000 kilomètres carrés"), contains a very interesting fauna. Among other fishes Plagiostomes of a characteristic marine facies are found in it, especially species of *Pristis*, or saw-fish.

¶ Czerniavsky's paper was published at Moscow in a pamphlet of such limited circulation that it has even escaped the notice of Fedtschenko and von Kennel; I am acquainted with it only through a statement by Leuckart ("Bericht über wiss. Leistungen in den Jahren 1868 und 1869," Arch. f. Naturgeschichte, 33 Jahrg. 1869, Bd. ii. p. 212). The study of the fauna of Lake Paleostom, which was separated from the Black Sea at a recent epoch, would furnish arguments analogous to those which result from the papers of von Kennel, which are mentioned below.

¶ 'Procès-verb. Soc. imp. amis Sc. nat. Antarop. et Ethnogr. Université de Moscou,' vol. x.

** Zeitschr. f. wiss. Zool. Bd. xli. Heft 1.

State), and which he regards as identical with all those which have been mentioned above, always excepting *Nemertes polyhopla*, Schmarda.

This view is adopted by Dr. von Marenzeller*, who believes that the Nemerteans mentioned by Kraepelin† as occurring in the water-supply of Hamburg belong to the same species.

It was probably the same worm again which was met with first at Wurzburg and again in Livonia by von Kennel‡, in the Lake of Geneva by du Plessis, and perhaps even in the neighbourhood of Bagamoyo, on the east coast of Africa, near Zanzibar, by Dr. Stuhlman§.

There is nothing which need astonish us in a geographical distribution like this if we think of many of the analogous facts which are known for a certain number of freshwater Rhabdocoelous. Many Hirudinea are without doubt more widely distributed than has hitherto been believed||. The same is true of the species of *Hydra*, which are found by travelling naturalists in countries widely distant from one another, if only they take the trouble to look for them¶. A host of Rotifers are in the same case. Lastly the freshwater Crustacea furnish very remarkable examples in this respect. Thus *Cyclops Leuckarti*, G. O. Sars, so widely distributed in Europe, is met with in Senegal, Madagascar, Ceylon, Sumatra, Celebes, and Australia**. *Branchipus auritus*, Koch, which I recently mentioned as occurring in Madagascar††, likewise exists in Central and Eastern Europe, in Egypt, the Sahara, North America, Florida, Texas, Mexico, the Antilles (San Domingo), and at Port Natal. Thus Darwin's views as to the dispersion of freshwater forms, which were so just, become more and more confirmed‡‡.

At all events, peculiar interest is afforded by the fluviatile Nemertean observed by von Kennel in Livonia. For this case really exhibits in a striking manner the method of penetration of a marine worm into fresh water. The Nemertean in question was found in an old branch of the Embach, an affluent of Lake Peipus. Now there is no room for doubt that Lake Peipus is (like Lake Paleostom,

* Zool. Jahrbücher (Systematik), Bd. iii.

† 'Abhandl. a. d. Geb. der Naturwissenschaft, herausgegeben vom Naturw. Vereine in Hamburg,' Bd. ix. Heft 1.

‡ Sitzungsab. der Naturf. Gesellsch. bei der Univ. Dorpat, Bd. viii. Heft 3.

§ Sitzungsab. der k. Akad. der Wiss. Berlin, Bd. xlix. (Dec. 6, 1888).

|| An obliging communication from Dr. Raphaël Blanchard enables me to announce the occurrence in Chili of *Glossiphonia tessellata*, O. F. Müller—the very leech which I have shown to be disseminated by the Palmipeds (Compt. Rend. Soc. de Biol. 30 janvier, 1892; Ann. & Mag. Nat. Hist., July 1892).

¶ *Hydra*, which is so well known in Europe and the United States, is found everywhere, although it is hardly possible to distinguish the species; it occurs in Victoria, in Australia (von Lendenfeld), New Zealand (Coughtrey), Zanzibar (Stuhlmann), and the Azores (Th. Barrois). I am likewise able to report the existence of *Hydra* in Senegal, near Rufisque, where it was obtained by M. Chevreux in 1890.

** Bull. Soc. Ent. de France, séance du 24 février, 1892.

†† J. de Guerne and J. Richard, Bull. Soc. Zool. de France, vol. xvi. 27 octobre, 1891.

which was mentioned above) an old arm of the sea which has been separated from the Gulf of Finland and whose waters have gradually lost their saltness. According to von Kennel the Nemertean found by him in the Embach is very closely allied to *Tetrastemma obscurum* of Max Schultze, a species which is freely marine in the North Sea, but which, on the other hand, is found to be the only one capable of enduring the extreme reduction in saltness of the waters of the Gulf of Finland. This species has been encountered as far as Revel and Helsingfors. It lives in this region, in a medium which is scarcely brackish, in company with Planarians, Oligochaetes, and various distinctly fluviatile types*. May we not fairly conclude from this that, if not *T. obscurum*, at least one or more allied forms have become little by little and definitely accustomed to fresh water, and have become distributed there in time and by degrees, as is the rule in the case of fluviatile animals?

I would add that Nemerteans appear to enjoy quite a special plasticity for adapting themselves to the most varied conditions of existence. At the present moment four terrestrial species are known. The first of these (*Geonemertes palaensis*) was reported in 1863 from the Palaos Islands, Micronesia, by Prof. C. Semper. Ten years later Willemoes-Suhm discovered a second (*Tetrastemma agricola*) at the Bermudas during the 'Challenger' expedition. In 1879 G. Gulliver described *Tetrastemma rodericianum*, which he had found in the Island of Rodriguez (Indian Ocean), and almost simultaneously Prof. von Graff published an excellent study upon *Geonemertes chalicophora*†. The patria of this latter species is still unknown; like several Oligochaetes or terrestrial Planarians, and the famous freshwater Medusa which was discovered in London in a tank in Regent's Park‡, it was taken alive in the palm-house of the Botanical Gardens at Frankfurt on the Main at the foot of a *Corypha*, which had come without doubt from Australia—a fresh proof of the facility with which organisms which are apparently the most delicate are capable of disseminating themselves.

These facts speak for themselves: they enable us to follow and to understand the process, slow no doubt, but continuous, by which first the fresh water and then the dry land have become peopled in the course of ages. Their force increases owing to the very fact of their being grouped together, and I therefore think that a note like this, though it should diminish the surprise caused by certain discoveries, is not entirely destitute of interest from a general point of view.—*Comptes Rendus hebdomadaires des séances de la Société de Biologie* (Séance du 30 avril, 1892): from a separate impression communicated by the Author.

* Max Braun, Arch. f. Naturkunde Liv-, Esthl- u. Kurlands, 2 Folge, Bd. x. (1884); Axel Spooß, 'Turbellaria, Discophora, et Oligochaeta fennica,' 1889.

† Zeitschr. f. wiss. Zool. Bd. xiii. (1863); Ann. & Mag. Nat. Hist. ser. 4, vol. xiii. (1874); Phil. Trans. vol. clxviii. (1879); Morphol. Jahrb. Bd. v. (1879).

‡ *Bipalium kewense*, Moseley, of the hothouses at Kew Gardens &c. Vide J. de Guerne, 'Excursions zoologiques dans les îles de Fayal et San Miguel (Azores),' Paris, 1888, Chap. ix. See likewise J. de Guerne, 'Méduses d'eau douce et d'eau saumâtre' &c., Bull. scient. dép. du Nord,

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XXII.—*On some new or rare Crustacea from the Firth of Forth.* By THOMAS SCOTT, F.L.S., Naturalist to the Fishery Board for Scotland, and ANDREW SCOTT.

[Plates XV. & XVI.]

Lichomolgus agilis, sp. n. (provisional name).
(Pl. XV. figs. 1–14.)

Description.—Length, exclusive of caudal setæ, 1·38 millim. The cephalothorax, seen from above, is broadly ovate, composed of five segments, the first being longer than the combined length of the other four. Rostrum prominent, produced downwards at nearly right angles and ending in a sharp point. Anterior antennæ scarcely half the length of the first body-segment, seven-jointed, alike in both sexes, the proportional lengths of the joints being nearly as in the annexed formula—

$$\frac{12-23-11-14-12-13-8}{1-2-3-4-5-6-7}$$

—sparingly setiferous; a small sensory filament springs from near the base of the fifth joint (Pl. XV. fig. 2). Posterior antennæ stout, four-jointed, the second joint fully twice the length of the next two together and having the lower margin produced forward into a digitiform process which extends beyond the middle of the third joint; the third and fourth joints are short, the penultimate one being the shortest, while the last joint is armed at the extremity with a moderately

short but stout and strongly hooked spine and four small setæ (fig. 3). A short trumpet-shaped siphon, capable of being extended or depressed, is situated nearly between the bases of the posterior antennæ, as shown in fig. 4 c (see also fig. 5). The other mouth-organs are nearly as in *Lichomolgus forficula*, Thorell, except that the mandible has no fringe of hairs on its upper margin and a prominent spiniform seta springs from the basal part of the anterior foot-jaw (figs. 6 and 7). The posterior foot-jaws differ considerably in the two sexes: those of the male are armed with extremely long and powerful falciform terminal claws, which are provided with a small spiniform seta at their base; the upper margin of the proximal half of the last joint is fringed with small teeth, and a spiniform seta springs from each side and near the middle of the same joint: the female foot-jaw, which gradually tapers towards the extremity, terminates in a short and stout claw, about half as long again as the joint from which it springs (fig. 9). The first four pairs of swimming-feet have both branches three-jointed; the last joint of the outer branch of the first pair is furnished with four dagger-shaped spines on the outer margin, the subterminal spine being longer than the others; the last joint of the outer branch of the fourth pair has one dagger-shaped terminal spine and two on the exterior margin; the last joint of the inner branches also bears dagger-shaped spines, and the inner margins of both branches are clothed with elongate plumose hairs; the spines and plumose hairs of the last joint of the inner branches of the four pairs are arranged in the following order:—in that of the first pair there are five hairs round the inner margin and end and one dagger-shaped spine on the exterior margin; that of the second pair has three hairs on the inner margin, two spines on the outer margin, and one terminal spine; that of the third pair has two hairs on the inner margin and three spines arranged as in the second pair; in that of the fourth pair there are no hairs on the inner margin, but there are two elongate spines, one terminal and one subterminal (figs. 10 and 11). The fifth pair in both sexes are small and provided with two terminal setæ, one being moderately long and slender and one stout and spiniform (fig. 12). Abdomen elongate, composed in the female of four, in the male of five segments: the first segment in both sexes is large and tumid, the greatest breadth of this segment in the female is near the middle, but in the male it is broadest at the distal end; the postero-lateral angles of this segment in the male are each furnished with two small setæ; the remaining segments are comparatively small and

subequal in length. Caudal stylets rather longer than the last two abdominal segments and provided with four setæ of very unequal length, the inner one of the two middle setæ being much longer than the others and more than twice the length of the stylet; a small seta also springs from the outer margin and near the middle of each stylet; the stylets of the male are rather longer than those of the female. Ovisacs two, large.

Hab. Within the siphons and between the branchial folds and body of the common cockle (*Cardium edule*), Firth of Forth and Morecambe Bay.

Remarks.—This species, though differing somewhat from the generic description of *Lichomolgus*, especially in having the inner branch of the fourth pair of swimming-feet three-jointed, agrees generally with the characters of that genus; it seems better therefore, for the present at least, to refer it to *Lichomolgus*.

Lichomolgus agilis was first observed in specimens of *Cardium edule* from Morecambe, Lancashire, and more recently in specimens of the same species of cockle from the vicinity of Cramond, Firth of Forth. The Copepod was obtained in at least 90 per cent. of the cockles examined, and appears to be moderately common—as many as sixteen specimens were taken from a single cockle. They are very active in their movements: if the shell of a living mollusk be opened, so that some of the contained water remains in the hollow of the opened shell-valves, the Entomostracan may be observed darting hither and thither in the water; not unfrequently their presence is indicated only by the dark-coloured line of the alimentary canal, their body being otherwise so transparent as to be scarcely visible in the water. When the Copepod is removed from the water the ovisacs, when present, are very conspicuous; they are about half as long as the animal, nearly straight along the inner edge, while the outer margin is a flattened but evenly rounded curve.

The presence of this Crustacean does not seem to be due to or to indicate an unhealthy condition of the mollusk which forms its host.

? *Enterocola eruca*, Norman. (Pl. XVI. figs. 1–11.)

Enterocola eruca, Brady, Mon. Brit. Copep. vol. i. p. 147 (1878).

Description.—Length, exclusive of ovisacs, 4.5 millim. (nearly $\frac{1}{5}$ of an inch), and including ovisacs 13 millim. (fully $\frac{1}{2}$ an inch). Body seen from above somewhat cylindrical, but rather narrower towards the anterior end, and composed of four distinct and subequal segments; there is a constriction

between the head and first thoracic somite, which in some positions has the appearance of a true joint, especially if the specimen has been a considerable time in spirit; the forehead is rounded and furnished with a very small rostrum. The last body-segment is produced laterally near the distal end and on the dorsal aspect into two digitiform processes, as shown in Pl. XVI. figs. 2 and 3. Anterior antennæ very short, stout, three-jointed, truncate at the end, and armed with several terminal, somewhat conical teeth, the two upper being considerably larger than the others; the first joint is proportionally large, the second and third very short (fig. 4). Posterior antennæ two-jointed; the end of the last joint bears four conical teeth, one terminal and three marginal (fig. 5). ?Mandibles rudimentary, composed of three nearly equal and rounded lobes (fig. 6). Anterior foot-jaw small, one-jointed, and bearing two terminal spines (fig. 7). Posterior foot-jaw large, three-jointed, considerably dilated at the base, but gradually decreasing in breadth towards the extremity and armed with a short but stout terminal claw, which has a broadly rounded lobe on the inner edge (fig. 8). The first four pairs of feet are nearly alike, and resemble the posterior antennæ in general appearance: the inner branch of all the four pairs is a short and broad rudimentary appendage apparently unfurnished with spines or setæ of any kind; the outer branch is comparatively narrow and elongate; in the first pair this branch is furnished with four small spiniform teeth, one being terminal and three marginal (fig. 9); that of the second pair has one terminal and two marginal, and that of the third and fourth pairs is furnished with one terminal and one marginal tooth (fig. 10). Abdomen very short and rudimentary, composed of three joints, the middle one being smaller than the other two; the end of the last joint is somewhat bifid, and each of the postero-lateral angles terminates in a small tooth-like spine (fig. 11). Ovisacs two, cylindrical, and about twice the length of the animal (fig. 1); they are attached at the base and towards the dorsal aspect of the last thoracic segment. Colour opaque white.

Hab. In the intestine, *not the branchial cavity*, of *Ascidia ?intestinalis*, dredged near Inchkeith, Firth of Forth.

Remarks.—Four specimens of this parasite were obtained in the intestine of four Ascidians (one in each Ascidian) during March 1891, and are recorded in the 'Ninth Annual Report of the Fishery Board for Scotland,' part iii. p. 301; one of these possessed a small portion of the basal part of two ovisacs. A short time ago another specimen of the same parasite was obtained in the intestine of the same species of

Ascidian in which the others occurred, and this one carried two long and slender ovisacs. Considerable difficulty was experienced in dissecting out the parasite from the intestine of the Ascidian, owing to the ovisacs being so slender and fragile; this character of the ovisacs possibly explains why they have been so rarely observed.

These Forth specimens appear to be identical with *Enterocola eruca*, Norman, a species obtained by the Rev. A. M. Norman while dredging among the Shetland Islands, and described in the Report of the Meeting of the British Association for 1868. One of the Forth specimens obtained last year was submitted to Prof. G. S. Brady, and he considered it to be identical with the species described by Dr. Norman.

In the 'Monograph of the British Copepoda,' by Prof. G. S. Brady, that author, while including *Enterocola*, M. van Beneden, in the family Buproridæ, did so in deference to Dr. Claus's opinion, but at the same time expressed himself as doubtful of this being its proper position.

Though the *Enterocola* from the Firth of Forth agrees to some extent with the characters of the family Buproridæ as described in the 'Monograph of the British Copepoda,' it differs in one important character: the Buproridæ are described as having "no external ovisac," but the Forth *Enterocola* possesses two ovisacs which are well developed. The *Enterocola* described and figured by M. van Beneden in the 'Bulletins de l'Académie Royale de Bruxelles,' 2^e série, tome ix. (1860), p. 155, as *Enterocola fulgens*, though certainly quite distinct from the Forth species, agrees with it in also possessing two external ovisacs; these ovisacs, if not so large as those of our specimen, are yet of considerable size; M. van Beneden's figure shows them to be nearly as long as the animal.

This marked difference between *Enterocola* and the Buproridæ shows the correctness of Prof. Brady's doubt as to the position of *Enterocola*. If one of the characters that distinguish the Buproridæ be the absence of external ovisacs, the position of *Enterocola* in that family becomes untenable.

Bathyporeia norvegica, G. O. Sars.

This Amphipod has recently been obtained in the Firth of Forth, where it appears to be a rare species.

Cerapis crassicornis (Spence Bate), = *Siphonæcetus crassicornis*, Spence Bate, has also been recently obtained in the Forth. It was observed in some material collected by means of a tow-net worked near the bottom. One specimen only

was taken; it inhabited a tube a little longer than itself, formed of fine black mud bound together with some kind of glutinous substance.

Petalomera declivis, G. O. Sars.

This little Cumacean was taken in the Firth of Forth some time ago, but not identified at the time. The Rev. T. R. R. Stebbing, M.A., to whom we are indebted for the names of these three species, states that *Petalomera declivis* "has probably not yet been recorded as British."

EXPLANATION OF THE PLATES.

PLATE XV.

Lichomolgus agilis, sp. n.

- Fig. 1. Adult female, seen from above. Magn. 46·7 diam.
- Fig. 2. Anterior antennæ. Magn. 190 diam.
- Fig. 3. Posterior antennæ. Magn. 127 diam.
- Fig. 4. First segment of body. Magn. 80 diam. *a*, rostrum; *b*, anterior antennæ; *c*, siphon; *d*, posterior antennæ; *e*, mandible; *f*, maxilla; *g*, first foot-jaw; *h*, second foot-jaw; *i*, first feet.
- Fig. 5. Rostrum (*r*); siphon (*s*). Magn. 95 diam.
- Fig. 6. Mandible; maxilla (*a*). Magn. 460 diam.
- Fig. 7. Anterior foot-jaw. Magn. 460 diam.
- Fig. 8. Posterior foot-jaw of male. Magn. 253 diam.
- Fig. 9. Posterior foot-jaw of female. Magn. 253 diam.
- Fig. 10. Foot of first pair. Magn. 190 diam.
- Fig. 11. Foot of fourth pair. Magn. 190 diam.
- Fig. 12. Foot of fifth pair. Magn. 380 diam.
- Fig. 13. Abdomen of female. Magn. 80 diam.
- Fig. 14. Abdomen of male. Magn. 80 diam.

PLATE XVI.

? *Enterocola eruca*, Norman.

- Fig. 1. Adult female, seen from below. Magn. 16·6 diam.
- Fig. 2. Adult female, seen from right side. Magn. 16·6 diam.
- Fig. 3. Adult female, seen from above. Magn. 345 diam.
- Fig. 4. Anterior antennæ. Magn. 345 diam.
- Fig. 5. Posterior antennæ. Magn. 247 diam.
- Fig. 6. Mandibles. Magn. 247 diam.
- Fig. 7. Anterior foot-jaw. Magn. 690 diam.
- Fig. 8. Posterior foot-jaw. Magn. 345 diam.
- Fig. 9. Foot of first pair. Magn. 190 diam.
- Fig. 10. Foot of fourth pair. Magn. 190 diam.
- Fig. 11. Abdomen of female. Magn. 40 diam.

XXIII.—*Natural History Notes from H.M. Indian Marine Survey Steamer 'Investigator,' Lieut. Gordon S Gunn, R.N., commanding.*—Series II., No. 6. *A case of Commensalism between a Gymnoblastic Anthomedusoid (Stylactis minoi) and a Scorpionoid Fish (Minous inermis).* By A. ALCOCK, M.B., Surgeon I.M.S., Surgeon-Naturalist to the Survey.

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- § 1. Introductory : some Illustrations of Symbiosis already reported from among the Gymnoblastic Hydroids.
- § 2. An Account of a Species of *Stylactis* always found associated with a *Minous*.
- § 3. Description of the *Stylactis*.
- § 4. Note on the *Minous*.

§ 1. *Introductory : some Illustrations of Symbiosis already reported from among the Gymnoblastic Hydroids.*

MANY observers have remarked upon the existence of life-associations between Gymnoblastic Hydrozoa and other animals. Such associations may be classed as (1) accidental, (2) commensal, and (3) parasitic; and though it is not easy always to be sure into which of these classes any given case shall fall, yet for the purposes of this paper it will be convenient to consider the three classes separately.

What may be regarded as instances of accidental association are too numerous to mention. Such most probably are many of those related or quoted by Professor Allman in his beautiful monograph on the Gymnoblastic Hydroids; of *Antigonium pusillum* found by Professor Van Beneden attached to crabs (and to various other bodies); of *Dicoryne conferta* investing shells of various Gastropod mollusks; of *Perigonimus muscoides*, *P. repens*, *P. palliatus*, and *P. linearis*, all occasionally found on tests of ascidians, on crustaceans, and on shells of living mollusks; of *Eudendrium capillare*, sometimes found upon ascidians; of *Hydractinia echinata* and *H. polyclina*, sometimes attached to hermit-crabs; and of *Ectopleura Dumortieri* found on crabs and on *Flustra* among other objects. Accidental, probably, too are the attachments noted by Professor Van Beneden in his "Animal Parasites and Messmates" of a *Tubularia* to a Cephalopod (observed by Gwyn Jeffreys) and of a *Tubularia* sometimes growing on a living sponge.

There seems, however, to be something more than a mere chance association in the cases recorded by Professor Allman of *Corynitis Agassizii* found by M'Grady growing only on

sponges, and of *Hydranthea margarica* found by the Rev. T. Hincks only on *Flustra*. Even the cases of *Lar sabellarum*, found by Gosse, as reported by Allman, only on the tubes of *Sabella*, and of *Stylactis vermicola* found by the 'Challenger' only upon a bathybial annelid (Allman, 'Challenger' Hydroids, part ii. p. 2, pl. i. fig. 2), may come under the head of accidental association, though they far more probably are examples of a definitely established symbiosis.

Among the best of the cases of undoubted commensalism, in which one of the associates is a Gymnoblastic Hydroid, are those discovered by Professor Hæckel ('Challenger' Deep-sea Keratosa, pp. 75-81, pl. ii. figs. 5, 6, and 7, pl. iv. fig. 4), of *Stylactis* (*Stylactella*) *spongicola* and *abyssicola*, and *Eudendrium*? sp., always found symbiotic with certain deep-sea horny sponges. Here the ramifying hydrorhiza of the polyp, which is greatly developed, affords by its chitinous perisarc a solid supporting framework for the sponge, and determines the form of the latter. The trophosome, on the other hand, is represented by significantly small hydranths.

Another instance of mutual relations almost as intimate is that reported by Korotneff (Zeitschr. für wiss. Zool. Bd. xlv. p. 486, Taf. xxiii. figs. 18-22), of a *Tubularia* (*T. parasitica*) living with a *Gorgonia*, the latter having no axis of its own, but using the stem of the *Tubularia* for a support.

Professor Allman, in his beautiful Monograph, quotes several cases that can hardly be regarded but as exemplifying definite associations for mutual benefit. He himself found *Perigonimus minutus* entirely confined to the living shells of a gastropod mollusk (*Turritella communis*), the polyp-colonies forming a fringe round the operculum of the mollusk in all of about thirty shells dredged. He also quotes the records of other observers, of which the two most remarkable are that of Canon Norman (of *Merona cornucopiæ* found only on living shells of *Astarte sulcata* and *Dentalium entalis* from 80 to 100 fathoms) and that of Professor Gegenbaur (of *Campaniclavara cleodora* confined to living shells of the pelagic *Cleodora tricuspidata* in thirty-two out of forty specimens of the latter examined).

In cases where a hydroid allies itself with a locomotive animal the advantages that the polyps derive from the partnership are very clear; for, as previous observers have pointed out, the polyps, instead of being entirely dependent on chance movements of the sea for uncertain supplies of food and air (as when attached to fixed objects), or for uncertain driftings towards food (as when attached to floating bodies), are rapidly

conveyed from one certain feeding-ground to another by intelligent and deeply self-interested agents. The locomotive agents on their part may be supposed to benefit either by the concealment or protection that a coat of urticating polyps affords, or by the disguise, that it facilitates in the search for prey.

Well-known cases of Hydroida undoubtedly parasitic—not here to refer to *Cunina*, as only the Gymnoblastic Hydrozoa are under consideration—are those of *Polypodium hydriforme*, Ussow, parasitic in the eggs of the sterlet fish, and of *Hydrichthys mirus*, Fewkes, parasitic on the Carangoid fish *Seriola zonata*, Cuv.

Polypodium hydriforme (Ussow, "A new Form of Fresh-water Coelenterate," Ann. & Mag. Nat. Hist. ser. 5, vol. xviii. p. 110, pl. iv., translated by W. S. Dallas from Morphol. Jahrb. Bd. xii.) begins its existence as a vermiform body within the ovarian eggs of a species of sturgeon. Upon this vermiform body primary and secondary buds appear which, after five or six months of parasitic life, when the sterlet's eggs escape from the ovary into the water, give rise to thirty-two hydriform organisms that live free in the Volga.

The case of *Hydrichthys mirus* parasitic on *Seriola zonata* is reported by Fewkes (Proc. Boston Nat. Hist. Soc. vol. xxiii.; Bull. Mus. Comp. Zool. vol. xiii. p. 224, pls. iv. and v.; Ann. & Mag. Nat. Hist. ser. 6, vol. i. p. 362; 'Nature,' vol. xxxvi. p. 604). The *Hydrichthys* colony, which consists of botroidal gonosomes and filiform bodies (hydranths?), is attached to its fish host by a basal plate with ramifying tubes.

The filiform bodies, which are regarded as degenerate hydranths, are destitute of tentacles, and the absence of tentacles is believed to be the obverse expression of the fact that the hydranths cannot catch food for themselves, and so draw upon the fish as parasites.

Mention must also be made of *Corydendrium parasiticum*, Cavolini, supposed by Cavolini, as quoted in Professor Allman's monograph, to be a parasite living at the expense of another Gymnoblastic Hydroid—*Eudendrium racemosum*. But the parasitism here is doubtful.

In the present paper I have to record a case of symbiosis between a fixed gymnoblastic Hydroid (a species of *Stylactis*) and a high locomotive animal (a fish of the genus *Minous*), in which it appears to me that the association is neither accidental

nor parasitic. It seems indeed on better grounds than those of mere exclusion to be a very complete and unequivocal instance of commensalism—complete because the reciprocal benefits appear to be very clearly defined, and unequivocal because it has been observed three times in places widely distant from one another.

§ 2. *An Account of a Species of Stylactis always found associated with a Minous.*

On March 26th, 1889, there were trawled from 70 fathoms off the Godáviri Delta, on the Coromandel coast, on a bottom of river-borne mud, two specimens of a small fish of the Scorpæoid genus *Minous*, one of which was covered with a fleshy colony of small polyps, which I then thought to be a species of *Podocoryne*. The fish was described in the 'Journal of the Asiatic Society of Bengal,' pt. ii. of vol. lviii. for 1889, as *Minous inermis*, sp. n.

There occurred in the trawl at the same time ten specimens of the Leucosine crab *Parilia Alcocki*, W.-M.; five specimens of the Portunid crab *Goniosoma hoplites*, W.-M., var.; many specimens of the Penaid *Solenocera Hextii*, W.-M.; and about two dozen specimens of the gastropod mollusk *Rostellaria delicatula*, Nevill.

The fleshy polyp found on *Minous inermis* was not present on any of these; and although most of the specimens of *Parilia* were a good deal incrustated with foreign growths, the only gymnoblastic Hydroid found on any of them was a *Perigonimus* very closely related to, if not identical with, *Perigonimus vestitus*, Allman.

Minous inermis was not again met with until November 4, 1891, when in a trawl hauled in 45 fathoms off the Malabar coast, on a bottom of sand mixed with a shingle of broken shells and echinoderm tests, nine specimens were taken, of which all but one were thickly beset, especially round the gill-opening and on the throat and in the axilla, with the same fleshy colonies of the same polyp as was found incrusting the type specimen of 1889. The haul was a big and varied one, including among fishes similar in habitat to *Minous inermis* (ground lovers), *Minous coccineus*, *Pterois brachyptera*, Cuv. & Val., *Uranoscopus crassiceps*, *Champsodon vorax*, Gthr., and two species of *Platycephalus*; among ground-living Crustacea several species of Leucosine crabs and two species of Raninoids; and several hundred living specimens of six species of gastropod mollusks.

On not one of these was the polyp of *Minous inermis* seen though upon some specimens of a *Leucosia* crab I have since found, in a condition too bad for accurate determination, colonies of a Hydroid with a conspicuous perisarc continued up to the tentacles, and with pedunculated sporosacs (?), that may be a *Bimeria*, or a *Garveia*, or perhaps *Eudendrium vestitum*, Allman.

Minous inermis was found a third time in a small but valuable collection of fishes presented to the Indian Museum by Mr. H. I. Row, a gentleman who has lately been attracted to the still but little appreciated Indian sea-fisheries. In January of this year Mr. Row dredged a single specimen, in about 70 fathoms of water, somewhere between the delta of the Ganges and that of the Máhánaddi, and along with it numerous specimens of *Minous coccineus*, *Lophius indicus*, *Trigla hemisticta*, Schleg., *Lepidotrigla spiloptera*, Gthr., and *Laeops Guentheri*, all of which undoubtedly share the habitat of *Minous inermis*. Now, though no epizoon of any sort can be found upon any of these fishes last named, yet the single specimen of *Minous inermis* is coated with the same fleshy polyp-colonies as were found upon this fish on the two previous occasions of its capture.

It may be stated in anticipation that in the January specimen the reproductive elements of the colony are particularly well and extensively developed, and that there is now good evidence that the Hydroid is not *Podocoryne*, as was supposed at first, but a *Stylactis* of a species that seems to be undescribed. In the sequel it is described as *Stylactis minoi*.

From the foregoing accounts it will, I think, be admitted that we have proved the existence of a definite symbiosis between the polyp and the fish. Accident will hardly account for the facts, (1) that we never find the *Minous* without the *Stylactis* or the *Stylactis* without the *Minous*; (2) that in two instances where two species of the genus occur together the polyp selects *Minous inermis*; and (3) that the association holds good for the northern half of the Bay of Bengal, for the southern half of the Bay of Bengal, and for the Laccadive or Malabar Sea.

The next question to be decided is, Is the symbiosis parasitic or commensal?

On general principles it is hardly justifiable to infer that an animal is a parasite unless it presents some evidences of degeneration, at any rate of some of the organs of nutrition. *Stylactis minoi*, however, is fully equipped for self-maintenance, the nutritive hydranths having a prominent hypo-

stome, a mouth capable of complete eversion, and long and very numerous tentacles. But beyond negative inference we have positive grounds for believing, not that the polyps live on the fish, but that the polyp-colony aids the fish quite as much as the fish aids the polyp-colony in a common competition for food.

The value of the association to the polyps has already, in the introduction, been suggested, and it only remains to state that their usual position upon the throat and round the gill-opening of the fish seems particularly to enhance the value of the alliance.

The following considerations lead to the belief that an equivalent benefit is enjoyed by the fish. Many of the Scorpænidæ—especially *Scorpena*, *Pterois*, *Synancidium*, and *Pelor*, and to a limited degree *Minous*—have the body and fins capriciously covered with long, wavy, often tufted cutaneous filaments; and no one who has watched such a fish as *Pterois volitans* in a reef-pool can doubt that these filaments serve what Mr. E. B. Poulton, in his book on 'The Colours of Animals,' calls a "special anticryptic" purpose. That is to say, they assist in giving the fish a deceitful resemblance to the incrustated rocks of its environment, in order to allure, or at any rate not to scare, prey. And it appears probable that *Stylactis minoi* enables its companion, *Minous inermis*, in the very same way to assume the same convenient and successful disguise.

§ 3. Description of the Stylactis.

STYLACTIS, Allman.

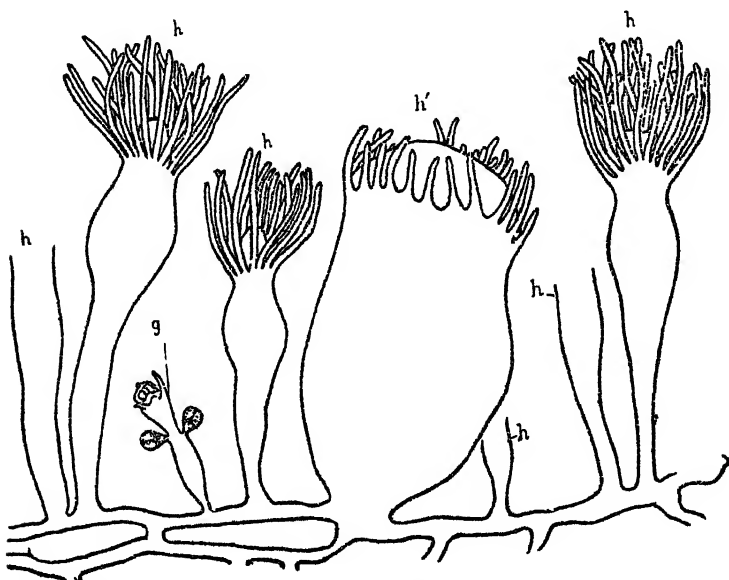
Stylactis, Allman, Monograph of the Gymnoblasic Hydroids, pt. ii., 1872, p. 302.

Stylactis minoi, sp. n.

The polyps, which are of two forms, sterile and proliferous, are all sessile upon a hydrorhiza that consists of a network of close-set ramifying and anastomosing tubes bounded by a flexible, extremely delicate, pellicular perisarc. The sterile polyps are of an elegant caryophyllaceous shape, and terminate in a conical hypostome, the base of which is encircled by a single crowded series of long filiform tentacles, to the number of twenty to twenty-four. In every colony a few large urn-shaped polyps are seen with broadened hypostome and more or less shortened tentacles; they appear to be merely sterile forms gorged with food. The average length

Gymnoblasic Anthomedusoid and a Scorpænoid

of the sterile polyps is about 2 millim. The proliferous polyps are very much smaller than the others, being on an average hardly one third of their length; they further differ in possessing but few—at most six—tentacles, and those short, slender, and fragile. Near the middle of their body they are



A small portion of a colony of *Stylactis minoi* detached from its fish commensal, $\times 42$. *h*, ordinary nutritive hydranths, some of which are not completely represented; *h'*, a nutritive hydranth gorged with food; *g*, a single proliferous person with two sporosacs.

much constricted, and here either two or three closed grape-stone-shaped sporosacs arise on very short peduncles. The proliferous polyps are very numerous in the specimens obtained in January, very few in those obtained in November, and apparently absent in those obtained in March.

§ 4. *Note on Minous inermis, Alcock.*

This small Scorpænoid fish was described and figured in J. A. S. B. vol. lviii. pt. ii., 1889, p. 299, pl. xxii. fig. 4. It differs from the other Indian species of the genus in having a thinner skin and in having the fin-spines and other spiny armature of the head (which are usually conspicuously well developed in Scorpænoid fishes) feeble.

It appears more than probable that this lack of defensive armature stands in some sort of direct relation with the presence of the polyps, for the latter would disguise the fish from its enemies no less than from its prey.

In conclusion I have to thank my friend Professor Wood-Mason for much friendly criticism and for directions to likely sources of information in zoological literature.

XXIV.—*Descriptions of Two new Bornean Squirrels.*

By OLDFIELD THOMAS.

THE extraordinary richness of the Bornean fauna in squirrels is again exemplified by the discovery of the two following new species sent home from North Borneo, the one by Mr. Everett and the other by Mr. C. Hose, both collectors well known for their many contributions to the fauna of the island.

Of the first species two specimens were obtained in 1880 in Sandakan by the late Mr. W. B. Pryer; but as neither was quite perfect, I have not previously described them. Now, however, that Mr. Everett has sent home a perfect specimen of the same form, I take the opportunity of describing it. It may be named, in honour of its original discoverer,

Sciurus Pryeri, sp. n.

Strongly resembling *Sciurus hippurus*, Geoff., in general appearance, although slightly smaller and more slenderly built, and agreeing precisely with that animal in the grizzled yellow colour of the back and the grey of the head and fore quarters, and their relative distributions on the anterior part of the body, but distinguished, firstly, by its wholly white instead of rich rufous belly; secondly, by its hips being yellowish like the back, instead of grey like the head; thirdly, by its feet being grizzled grey instead of black; and, finally, by its tail-hairs being broadly and conspicuously annulated with black and white, with white tips, instead of being wholly black. Premolars $\frac{2}{1}$; incisors orange-yellow, not darker above than below.

Dimensions of the type (an adult male in skin):—Head and body 260 millim.; tail 250; hind foot 54.

Hab. Of the type (B. M. 92. 7. 19. 1), Sapugaia River,

N. Borneo (killed Dec. 24, 1891) ; of Mr. Pryer's specimens, Sandakan.

Specimens of this interesting form have, as already mentioned, been in the Museum since 1880 ; and ever since they came I have been on the look out for more examples, to see how far their characters were constant. Now that Mr. Everett's specimen, which is chosen as the type, proves to agree with them in every respect, it is evident that the animal ought to go no longer undescribed, as it is clearly a distinct geographical race, differing in my opinion sufficiently to be called a species. At the same time I admit that some zoologists would consider it to be only a subspecies ; but even in that case it is one which clearly requires a name of its own.

A specimen of *S. hippurus* in the Museum from Mount Penrisen, Western Sarawak, is quite similar to Malaccan examples, and others from the south of the island, preserved in the Leyden Museum, are also of the usual red-bellied type. Nor, again, does the type of *S. hippurus*, var. *borneensis*, Gray *, show any approximation to *S. Pryeri*.

Sciurus Hosei, sp. n.

A striped squirrel of the size and somewhat the general appearance of *S. Berdmorei*, Bly., but the muzzle short, as in the ordinary species. Ground-colour of body olivaceous greenish grey, but this colour is only present in purity along the sides of the body and on the face, the nape and shoulders being suffused with fulvous, which narrows and brightens posteriorly into a defined dorsal fulvous line, on each side of which there are, firstly, a black, then a pale yellowish-white, and then another black line. The resulting effect is not unlike some of the darker-coloured specimens of *S. tristriatus*, Waterh. (although with the centre line deep fulvous), or of some of the varieties of *S. Berdmorei*. Under surface from chin to anus brilliant fulvous, the bases of the hairs whitish on the chest, greyish on the belly. Hands and feet grizzled with orange and black. Tail-hairs broadly ringed with bright fulvous and black, the tips of the hairs fulvous. Premolars $\frac{2}{1}$, at least in the milk-dentition ; incisors deep orange-red above, rather paler below.

Dimensions of the type (a slightly immature male in skin) :—

Head and body 245 millim. ; tail imperfect ; hind foot 42 ; combined length of three upper true molars 6.2 ; distance from front of $\frac{m-1}{1}$ to back of incisor 15.2.

* Ann. & Mag. Nat. Hist. (3) xx. p. 283 (1867).

Hab. Batu Sang Mount, Baram River, N. Borneo (5000 feet)*, Jan. 1892., Coll. C. Hose, Esq.

The type specimen of this striking species has unfortunately had its skull shattered by shot, so that an exact comparison with the skull of *S. Berdmorei* is impossible. At the same time enough remains to show that the muzzle is quite short, and not elongated as in the Malayan species; so that it would appear not to be a Bornean representative of that animal, as one would at first suppose. Of the short-snouted species the only one at all resembling it is *S. tristriatus*, whose South-Indian locality renders it very remarkable if *S. Hosei* really belongs to the same group. However, when fully adult specimens with perfect skulls are obtained, we may be able to determine what are its nearest allies; but in any case there can be no question as to its own specific distinction.

XXV.—*Spiders from Madeira*.

By CECIL WARBURTON, M.A., Christ's College, Cambridge.

[Plate XIV.]

THE Madeiran spiders which form the subject of the present memoir have been obtained from three distinct sources:—

1. Specimens collected by Mr. W. R. Ogilvie-Grant, Assistant in the Zoological Department of the British Museum, and placed in my hands by the courtesy of his colleague Mr. R. I. Pocock. This collection embraces thirty-two species, of which three are new to science.

2. Spiders collected by Mr. John Willis Clark, Registry of the University of Cambridge. Of the fifteen species contained in this collection one is new to science.

3. A few specimens, comprising eight species, collected by Padre Schmidt, of Madeira, and kindly brought to me by Mr. J. W. Clark.

My thanks are due to the gentlemen above named and also to the Rev. O. Pickard-Cambridge and M. Eugène Simon, from whom I have received valuable advice with regard to some of the more obscure species.

* This altitude rests on the statement of a native.

Attidæ.

Attus maderiana, sp. n., ♀. (Pl. XIV. fig. 1.)

| | millim. |
|-------------------------|---------|
| Cephalothorax | 2·5 |
| Abdomen | 1·5 |
| Length of legs: 1 . . . | 3·5 |
| 2 . . . | 3·0 |
| 3 . . . | 4·5 |
| 4 . . . | 5·0 |

Cephalothorax dark brown, merging to black on the caput, but with a narrow white lateral border, of which the inner edge is broken by a dark spot opposite the third leg. There is a conspicuous whitish spot behind each of the posterior eyes.

The *abdomen*, which is oval, is of a blackish-brown colour, variegated with some whitish spots and some angular markings of a yellowish hue.

Three white spots on either side correspond with, but do not quite meet, the angular circumflex-like markings, and are, so to speak, encroachments of the paler border of the abdomen. The extremities of the middle angular marking are also dilated to form two conspicuous whitish spots.

In the posterior half of the abdomen the pattern is complicated by two faint angular markings each in the form of an inverted circumflex.

The under surface of the abdomen and of the coxæ is pale, but the plastron is dark brown or black. The palpi are white. All the legs are distinctly annulated on the metatarsi and tarsi, but the femora and patellæ are of dark hue, and the former have black longitudinal striations.

A single female of this small spider was taken by Mr. Grant.

Marpissa Grantii, sp. n., ♀. (Pl. XIV. figs. 2 and 3.)

| | millim. |
|-------------------------|---------|
| Cephalothorax | 3·0 |
| Abdomen | 3·5 |
| Length of legs: 1 . . . | 5·5 |
| 2 . . . | 4·0 |
| 3 . . . | 4·5 |
| 4 . . . | 5·0 |

Cephalothorax dark red-brown, with a bronze hue on the caput. The ocular area is marked by a bent transverse bar of lighter hue.

The *abdomen* is oval, slightly narrower behind; its prevailing colour is a reddish yellow, due to certain characteristic markings on a dark background. Its anterior border is whitish, and two conspicuous white spots are connected with this border by reddish bands, emphasized by a dark intermediate space. The middle of the abdomen is reddish yellow, with paler divergent markings, which are best understood by reference to the figure. The lateral borders of the abdomen are reddish yellow and give out streaks towards the median angular lines.

The *plastron* is red-brown and the underside of the abdomen is pale with a dark median longitudinal line.

The legs resemble the abdomen in colour, being of a reddish yellow, broadly but not very distinctly annulated with brown. The first pair are darker hued and very powerful, with the *tibiæ* and *metatarsi* armed with strong spines. The *palpi* are of the colour of the posterior legs.

I have named this handsome spider after Mr. W. R. Ogilvie-Grant, whose interesting collection contains three females of this species.

Marpissa ornata, Thorell. (Pl. XIV. figs. 4-6.)

Marpissa ornata, Thorell, "Descriptions of several European and North-African Spiders," K. Svensk. Vet.-Ak. Handl. xiii. no. 5, p. 60.

The collection of Mr. Grant contains a mature female spider which answers well to the description given by Thorell of the above species. As that eminent author has confined himself to a Latin diagnosis without figures, I have thought it well to include drawings of the spider in the present memoir (Pl. XIV. figs. 4, 5, and 6).

Lycosidæ.

Tarentula (Lycosa) ingens, Blackwall.

Lycosa ingens, Blackwall, "Notes on Spiders," Ann. & Mag. Nat. Hist. ser. 3, vol. xx. p. 202 (1867).

A mature female of this fine species is included in the collection of Mr. Clark, and five in that of Mr. Grant. It exhibits considerable variation in size.

Tarentula ? sp.

Two specimens, too young for identification, in the collection of Mr. Grant.

Tarentula (Lycosa) maderiana, Walckenaer.

Lycosa tarentuloides maderiana, Walckenaer, 'Insectes aptères.'

Both sexes of this species are represented in Mr. Grant's collection.

Lycosa Herii, Thorell.

Lycosa Herii, Thorell, "Descriptions of several European and North-African Spiders," K. Svensk. Vet.-Akad. Handl. xiii. no. 5, p. 166.

One mature female of this species was captured by Mr. Grant.

Lycosa arenicola, Cambridge.

Lycosa arenicola, Cambridge, Ann. & Mag. Nat. Hist. 1875, vol. xvi. p. 253, pl. viii.

Mr. Clark captured several females and Mr. Grant one male of this species, which is now first recorded from Madeira.

Ocyale mirabilis, Clerck.

Ocyale mirabilis, Clerck, Blackwall, Spiders of Great Britain and Ireland, p. 37, pl. ii.

Specimens of both sexes of this species, for the most part immature, occur in the collections of Mr. Grant and Mr. Clark. Now first recorded from Madeira.

Thomisidæ.

Xysticus cristatus, Clerck.

Xysticus cristatus, Clerck, Sv. Spindl. p. 136, pl. vi.

Three females of this species occur in the collections of Mr. Grant and Mr. Clark. Now first recorded from Madeira.

Misumena Clarkii, sp. n., ♀. (Pl. XIV. figs. 7 and 8.)

| | millim. |
|-------------------------|---------|
| Cephalothorax | 2·5 |
| Abdomen | 4·5 |
| Length of legs: 1 . . . | 13·0 |
| 2 | 13·0 |
| 3 | 6·0 |
| 4 | 6·5 |

Cephalothorax and legs a rich glossy yellow. An indistinct paler streak down the middle of the cephalothorax. Ocular area prominent and of a dead whitish colour. Lateral anterior eyes largest. The anterior row distinctly convex towards the front and shorter than the posterior row, which is very slightly convex, the eyes being nearly equal in size and the medians somewhat nearer together than each is to the lateral.

Abdomen probably of a vivid green in life, showing when magnified a fine black reticulation. There are numerous short spines on black prominences under the tibiæ and metatarsi of the first and second pairs of legs.

I have named this spider after its discoverer, Mr. J. W. Clark, a single female being contained in his collection.

Epeiridæ.

Argiope aurelia, Savigny & Audouin.

Argiope aurelia, Savigny et Audouin, Descr. de l'Égypte, 2nd ed. xxii. p. 331, Arach. pl. i.

= *Argiope (Aranea) trifasciata*, Forsk.

This spider is represented in all three collections, that of Mr. Clark including specimens of the comparatively small male.

Epeira acalypha, Walck.

Epeira acalypha, Walck., Blackw. Spid. Gt. Brit. & Irel. p. 341, pl. xxv.

Eight females were collected by Mr. Clark and Mr. Grant. Now first recorded from Madeira.

Epeira solers, Walck.

Epeira solers, Walck., Blackw. Spid. Gt. Brit. & Irel. p. 336, pl. xxiv.

Apparently abundant in Madeira, though not hitherto recorded from that locality, Mr. Grant and Mr. Clark having both taken specimens.

Epeira cucurbitina, Clerck.

Epeira cucurbitina, Clerck, Blackw. Spid. Gt. Brit. & Irel. p. 342, pl. xxv.

A female of this species was taken by Mr. Clark, and a male, not quite mature, by Mr. Grant. Now first recorded from Madeira.

Epeira ? perplicata, Cambridge.

Epeira perplicata, Cambridge, "Spiders of Palestine," Proc. Zool. Soc. 1872, p. 300.

An immature female, probably belonging to this species, is included in Mr. Grant's collection.

Zilla x-notata, Clerck.

Araneus litera x-notatus, Clerck, Sv. Spindl. p. 46, pl. ii.

Numerous specimens of this widely distributed species were taken by Mr. Grant and Padre Schmidt. Now first recorded from Madeira.

Meta Meriannæ, Scopoli.

Meta Meriannæ, Scopoli, Ent. Carn. p. 395.

This species is well represented in Mr. Grant's collection. Now first recorded from Madeira.

Tetragnatha extensa, Linn.

Tetragnatha extensa, Linn., Blackw. Spid. Gt. Brit. & Irel. p. 367, pl. xxviii.

Mr. Grant and Mr. Clark have taken specimens of this species, which has not hitherto been recorded from Madeira.

Mithras paradoxus, C. Koch.

Mithras paradoxus, C. Koch, Herr.-Schäff. Deutschl. Ins. 123. 9.

Mr. Grant's collection contains a single female of this species. New to Madeira.

Theridionidæ.

Theridion rufolineatum, Lucas.

Theridion rufolineatum, Lucas, Explor. en Algérie, Arachn. p. 260, pl. xvi.

A single female of this species is included in Mr. Grant's collection.

Latrodectus 13-guttatus, Rossi.

Latrodectus 13-guttatus, Rossi (*Aranea 13-guttata*), Fauna Etr. ii. p. 136, pl. ix.

A female of the dark variety of this variable species was captured by Mr. Grant.

Lithyphantes nobilis, Thorell.

Lithyphantes nobilis, Thorell, "Descriptions of several European and North-African Spiders," K. Svensk. Vet.-Ak. Handl. xiii. no. 5, p. 60.

Mr. Grant's collection includes several females which I attribute to this species. I give a drawing (Pl. XIV. fig. 9) of the abdominal pattern, of which Thorell's description is as follows:—

"Antice fascia subtestacea cincto, cujus extremitates longe pone medium laterum pertinent, et in medio area oblonga, lata, inæquali, antice acuminata, pallida notato, quæ in medio maculas vel puncta duo nigro-picea ostendit, et lineis binis transversis cum fascia illa laterali utrinque conjungitur."

Lithyphantes (Latrodectus) distinctus, Blackwall.

Lithyphantes (Latrodectus) distinctus, Blackw. "Descriptions of newly discovered Spiders" &c., Ann. & Mag. Nat. Hist. ser. 3, vol. iv. p. 260 (1859).

Mr. Grant captured a single female of this species.

Pholcidae.

Pholcus phalangeoides, Blackw.

Pholcus phalangeoides, Blackw. Spid. Gt. Brit. & Irel. p. 208, pl. xv.

Specimens of this widely distributed species occur in each of the three collections under notice, both sexes being represented. Now first recorded from Madeira.

Agelenidae.

Tegenaria Derhamii, Scopoli.

Tegenaria Derhamii, Scopoli, Ent. Carn. p. 400.

Three females are included in Mr. Grant's collection. Now first recorded from Madeira.

Tegenaria Guyonii (= *T. parietina*, Frc.).

Tegenaria Guyonii, Guérin-Ménéville, Iconogr. du Règne Anim., Arachn. p. 7, pl. ii.

Several females, mostly immature, are found in all three collections under notice. New to Madeira, though recorded from the Azores &c.

Tegenaria pagana, C. Koch, 1841.

Padre Schmidt and Mr. Grant have each captured two females of this species, which has been recorded from St. Helena, but not hitherto from Madeira. (See Pl. XIV. fig. 10.)

Drassidæ.

Prosthesima, sp.

A spider of this genus, too immature for its species to be determinable, is included in the collection of Mr. Grant, who captured it in Deserta Grande.

Drassus delinquens, Cambridge.

Drassus delinquens, Cambridge, Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. p. 245, pl. viii., and ser. 5, vol. i. p. 110.

A single female of this species occurs in Mr. Grant's collection.

Clubiona decora, Blackwall.

Clubiona decora, Blackw. Ann. & Mag. Nat. Hist. ser. 3, vol. iv. (1859).

Mr. Grant captured a male *Clubiona* which I judge to belong to this species. Blackwall gives no figure, and Simon regards the synonymy of the species as uncertain. I therefore give a drawing of the abdominal pattern and of the palpus of this spider, which is apparently closely allied to *Cl. holosericea* (see Pl. XIV. figs. 11 and 12).

Dysderidæ.

Dysdera crocata?, C. L. Koch.

Dysdera crocata, C. L. Koch, Die Arachn. v. p. 81, pl. clxvi.

An immature specimen probably belonging to this species occurs in Mr. Clark's collection.

Segestria fiorentina, Rossi, = *Seg. perfida*, Walck.

Segestria perfida, Walck., Blackw. Spid. Gt. Brit. & Irel. p. 373, pl. xxviii.

Though not hitherto recorded from Madeira this species appears to be abundant there, as it is represented in all three collections.

Ariadne maderiana, sp. n., ♀ (not quite mature).
(Pl. XIV. fig. 13.)

| | millim. |
|-------------------------|---------|
| Cephalothorax | 3·5 |
| Abdomen | 3·5 |
| Length of legs: 1 . . . | 6·5 |
| 2 | 6·0 |
| 3 | 4·0 |
| 4 | 6·5 |

Cephalothorax of a nearly uniform yellow-brown, slightly darker towards the caput, which is laterally compressed. The eyes of each pair are almost contiguous, the laterals being situated on slight dark-coloured prominences.

Abdomen grey, without abdominal pattern and covered with a fine down; slightly broader and a trifle darker posteriorly.

Legs yellow, with the three terminal joints of 1 and the two terminal joints of 2 tinged with brown. All the femora are powerful, especially those of the fourth pair. There is one spine on the inner side of the femora of 1.

The tibiæ of 1 and 2 have on their undersides six or seven strong spines, some of them very long. The tibiæ of 1 are especially powerful, and hairy as well as spinous. There are two moderate spines under the tibiæ of 3; but the tibiæ of 4 are spineless.

The palpi are yellow, with the two terminal joints dark brown.

The spider here described was captured by Mr. Grant in the island of Deserta Grande. It is nearly allied to *Ariadne ionica*, Camb.*; but in that species there is no pubescence on the abdomen and the femora of the first and second pairs of legs are armed with six spines, while there are four on the femora of the third pair.

Filistatidæ.

Filistata testacea, Latreille.

Filistata testacea, Latreille, Consid. gén. p. 121.

Two females of this species were captured by Padre Schmidt. Now first recorded from Madeira.

* 'Journal of the Linnean Society,' Zool. 1873, vol. xi. p. 532.

Complete List of the Aranæ of Madeira as at present known.

ATTIDÆ.

- | | |
|---------------------------------------|--|
| <i>Salticus diligens</i> , Blackwall. | } The synonymy of these spiders is doubtful. |
| — <i>vafer</i> , Blackwall. | |
| — <i>catus</i> , Blackwall. | |
| — <i>vigilans</i> , Blackwall. | |
| <i>Marpissa ornata</i> , Thorell. | |
| — <i>Grantii</i> , Warburton. | |
| <i>Attus maderiana</i> , Warburton. | |

LYCOSIDÆ.

- Lycosa maderiana*, Walckenaer.
 — *ingens*, Blackwall.
 — *Herii*, Thorell.
 — *arenicola*, Cambridge. (England, Europe.)
Ocyale mirabilis, Clerck. (England, Europe.)

SPARASSIDÆ.

- Helicopsis (Olios ?) maderianus*, Thorell.

THOMISIDÆ.

- Xysticus spinifer*, Blackwall.
 — *insulanus*, Thorell.
 — *cristatus*, Clerck. (England, Europe.)
Misumena Clarkii, Warburton.

EPEIRIDÆ.

- Argiope aurelia*, Sav. et Aud., = *A. trifasciata*, Forsk. (Africa.)
Epeira hortensis, Blackwall.
 — *lentiginosa*, Blackwall.
 — *acalypha*, Walck. (England, Europe.)
 — *solers*, Walck. (England, Europe.)
 — *cucurbitina*, Clerck. (England, Europe.)
 — *perplicata* (?), Cambr. (Asia.)
Zilla x-notata, Clerck. (England, Europe.)
Meta Merianne, Scopoli. (England, Europe.)
Tetragnatha extensa, Linn. (England, Europe, Africa.)
Mithras paradoxus, C. Koch. (England, Europe, Africa.)

ULOBORIDÆ.

- Uloborus pallens*, Blackwall.
Hyptiotes flavidus, Blackwall.
 — *dubius*, Blackwall.

THERIDIONIDÆ.

- Theridion aulicum*, C. Koch. (Europe.)
 — *luteolum*, Bl.
 — *rufolineatum*, Lucas. (England, Europe, Africa.)

Lithyphantes distinctus, Blackwall.

— *nobilis*, Thorell.

Latrodectus 13-*guttatus*, Rossi. (Europe, Asia, Africa.)

Enoplognatha mandibularis. (Europe, Africa, Asia.)

Lonyphia (?) *Johnsoni*, Blackwall.

Erigone pigra, Blackwall.

Ecobius navus, Blackwall.

PHOLCIDÆ.

Pholcus phalangeoides, Blackwall. (Europe, America.)

DICTYNIDÆ.

Amaurobius affinis, Blackwall.

AGELENIDÆ.

Textrix obscura, Blackwall.

Tegenaria maderiana, Thorell.

— *pagana*, C. Koch. (Europe.)

— *parietina*, Fr., = *T. Guyonii*, Guérin-Ménéville. (England, Europe, Africa.)

— *Derhamii*, Scopoli. (England, Europe, N. America.)

DRASSIDÆ.

Drassus pictus, Thorell. (Europe.)

— *secretus*, Thorell.

— *delinquens*, Cambridge. (England.)

Prosthesima, sp. ?

Clubiona albidula, Blackwall.

— *decora*, Blackwall.

— *virgulata*, Blackwall.

Miltia (?) *lepida*, Blackwall.

SCYTOTIDÆ.

Loxosceles rufescens, Dufour. (Europe, Africa, Asia.)

Scytodes velutina, Lowe. (Africa.)

DYSDERIDÆ.

Oonops concolor, Blackwall.

Dysdera diversa, Blackwall.

— sp. ?

Segestria florentina, Rossi, = *S. perfida*, Walck. (Europe.)

Ariadne maderiana, Warburton.

FILISTATIDÆ.

Filistata testacea, Latreille. (Europe, Africa.)

From the foregoing list it appears that sixty-four species of spiders have at present been recorded from Madeira. Of these thirty-five are peculiar to the Madeira group, and one (*Uloborus pallens*) to those islands and the Canaries. The twenty-eight remaining species have a wider distribution,

twenty-four being known in Europe (fourteen in England), eight in Africa, three in Asia, and two in America.

It is probable that a more thorough acquaintance with the West-African fauna would reveal a much closer connexion between the Araneæ of that region and Madeira than our present knowledge shows to exist.

Bibliography.

Previous contributions to the Aranean fauna of Madeira are to be found in the following works:—

LOWE. "Descriptions of Two Species of Araneidæ, Natives of Madeira." Zoological Journal, vol. v. p. 322.
Species recorded:—*Loxosceles rufescens*, Duf., *Scytodes velutina*, Lowe.

BLACKWALL. "Descriptions of the Male of *Lycosa tarentuloides madeiriana*, Walck.," &c. Ann. & Mag. Nat. Hist. vol. xx. (1857) p. 282.

—. "Descriptions of newly-discovered Spiders captured by James Yates Johnson, Esq." Ann. & Mag. Nat. Hist. (ser. 3) vol. iv. (1859).

Species recorded:—*Clubiona albidula*, *C. virgulata*, *C. decora*, *Clotho lepida*, *Textrix obscura*, *Theridion luteolum*, *Lithyphantes (Latrodectus) distinctus*, *Linyphia Johnsoni*, *Epeira diversa*, *Ep. hortensis*, *Oonops concolor*, *Ecobius navus*.

—. "Descriptions of newly-discovered Spiders from the Island of Madeira." Ann. & Mag. Nat. Hist. (ser. 3) vol. ix. (1862) p. 370.

Species recorded:—*Xysticus (Thomisus) spinifer*, *Coniflo affinis*, *Velea pallens*, *Mithras flavidus*, *M. dubius*, *Theridion elegans*, *Neriere pigra*, *Epeira lentiginosa*, *Tetragnatha lineata*, *Dysdera diversa*, *Ecobius navus* (with added characteristics).

—. "Notes on Spiders," &c. Ann. & Mag. Nat. Hist. 1867, xx.

Species recorded:—*Lycosa ingens* (male characteristics), *Salicicus vafæ*, *S. catus*, *S. sublestus*, *S. vigilans*, and other spiders not from Madeira.

N.B.—Simon professes himself unable to determine the synonymy of the species of *Salicicus* here described by Blackwall. That author gives no figures, nor are his descriptions sufficient to determine with certainty to which of the genera into which the group has since been divided the several species belong.

CAMBRIDGE "On the Habits and Distribution of *Lycosa ingens*." Ann. & Mag. Nat. Hist. 1872, vol. x. p. 448.

THORELL. "Descriptions of several European and North-African Spiders." K. Svensk. Vet.-Akad. Handl. xiii. no. 5.

Madeiran species recorded:—*Marpissa ornata*, *Lycosa Heriü*, *Helicopsis madeiranus*, *Lithyphantes nobilis*, *Tegenaria madeiriana*, *Drassus pictus*, *Dr. secretus*.

SIMON. "Matériaux pour servir à la faune arachnologique des Iles de l'Océan Atlantique." Annales de la Société entomologique de France, (ser. 6) vol. iii. (1883).

EXPLANATION OF PLATE XIV.

- Fig. 1. *Attus maderiana*, sp. n., ♀. Much enlarged.
 Fig. 2. *Marpissa Grantii*, sp. n., ♀. Much enlarged.
 Fig. 3. Ditto. Epigyne.
 Fig. 4. *Marpissa ornata*, Thorell, ♀.
 Fig. 5. Ditto. Side view.
 Fig. 6. Ditto. Epigyne.
 Fig. 7. *Misumena Clarkii*, sp. n., ♀. Caput, with ocular area.
 Fig. 8. Ditto. Epigyne.
 Fig. 9. *Lithyphantes nobilis*, Thorell. Dorsal view of abdomen.
 Fig. 10. *Tegenaria pagana*, C. Koch. Epigyne of ♀.
 Fig. 11. *Chubiona decora*, Blackwall, ♂. Dorsal view of abdomen.
 Fig. 12. Ditto. Palpus of ♂.
 Fig. 13. *Ariadne maderiana*, sp. n., ♀ (not quite mature). Much enlarged.

N.B.—The types of the species now described as new are deposited in the British Museum.

XXVI.—*On the Preservation of Teleostean Ova.*
 By WALTER E. COLLINGE, St. Andrews University.

BETWEEN October 1891 and July 1892 upwards of 80,000 ova have been examined at the St. Andrews Marine Zoological Laboratory, comprising some thirty known and four or five unknown species. Upon a large number of these I have made numerous experiments with various preservatives, of which the following notes are an account of the results obtained.

Killing.

The most satisfactory results were obtained by adding to a vessel containing the ova, with about an ounce of sea-water, three or four drops of a saturated solution of picric acid, to which had been added 5 per cent. of hydrochloric acid. In this diluted solution they were allowed to remain for *not longer* than three minutes, during which time they were kept in motion by a pipette. When the ova remained for longer than the time stated, or when the solution was too strong, the yolk was generally ruptured and considerable wrinkling took place in the zona radiata. In other cases the yolk became considerably contracted. Like results ensued if they were not well washed in fresh water before being transferred to the preservative fluid. After washing in dilute alcohol 12½–25 per cent., a slight opacity followed. If killed in a saturated solution of corrosive sublimate 6 parts and 3 parts

of glacial acetic acid, they were also opaque when transferred to any of the following fluids.

Preservatives.

Some dozen or so of picric mixtures were tried of which the following are the principal :—

(1) In equal parts of a sat. sol. picro-hydroch. ac. and 50-per-cent. alcohol ova of *Trigla gurnardus* shrank $\cdot 1524$ millim.; the yolk was contracted and opaque; the oil-globule scarcely visible. In *Pleuronectes platessa* the shrinkage was slightly less *, being $\cdot 1447$ millim.

(2) Sat. sol. picric acid 1 part, glycerine 1 part, 60-per-cent. alcohol 2 parts.—*Motella mustella* shrank $\cdot 1524$ millim.; the oil-globule was fairly distinct.

(3) Sat. sol. picric acid 2 parts, alcohol 1 part.—Results very similar to method 1. Shrinkage fully $\cdot 1524$ millim.; oil-globule poor and embryo indistinct.

(4) Sat. sol. picric acid 2 parts, 50-per-cent. alcohol 4 parts, 2-per-cent. acetic acid 1 part.—*Motella mustella* and *Trigla gurnardus*: oil-globule and embryo indistinct; zona strongly wrinkled.

(5) Equal parts of sat. sol. picric acid, alcohol, and 2-per-cent. acetic acid.—The following ova were preserved in this fluid, of which the average shrinkage is given. The oil-globule, where present, was remarkably clear. Embryos very distinct. Ova previously prepared in other fluids, in which the oil-globule was scarcely or not at all visible, speedily came to view when allowed to remain in this fluid for five to twenty minutes.

| Species. | Average shrinkage. millim. |
|---------------------------------------|-------------------------------|
| <i>Trigla gurnardus</i> | $\cdot 1447$ |
| <i>Gadus morrhua</i> | $\cdot 1295$ |
| — <i>æglefinus</i> | $\cdot 1295$ |
| — <i>minutus</i> | $\cdot 1143$ |
| <i>Motella mustella</i> | $\cdot 990$ |
| <i>Brosmius brosme</i> | $\cdot 1371$ |
| <i>Hippoglossus limandoides</i> | $\cdot 1524$ |
| <i>Rhombus lævis</i> | $\cdot 1371$ |
| <i>Arnoglossus laterna</i> | $\cdot 1447$ |
| <i>Pleuronectes platessa</i> | $\cdot 914$ |
| <i>Clupea sprattus</i> | $\cdot 1143$ |

This was certainly the best of the picric solutions.

* The average is in all cases given.

(6) Alcohol 4 parts, 2-per-cent. acetic acid 4 parts, spirits of camphor 1 part.—The results here were very similar to the preceding fluid, but the embryos were not so distinct, owing to the slight opacity of the eggs; on the other hand, the shrinkage was very little. There are many objections to a picric solution which are here met. For general work or for preserving large collections of ova this is undoubtedly the best preservative I have used.

| Species. | Average shrinkage. |
|---------------------------------------|--------------------|
| | millim. |
| <i>Trigla gurnardus</i> | ·1371 |
| <i>Gadus morrhua</i> | ·1295 |
| — <i>æglefinus</i> | ·1295 |
| — <i>minutus</i> | ·1143 |
| <i>Motella mustella</i> | ·914 |
| <i>Brosmius brosme</i> | ·1143 |
| <i>Hippoglossus limandoides</i> | ·1219 |
| <i>Rhombus lævis</i> | ·1143 |
| <i>Arnoglossus laterna</i> | ·1219 |
| <i>Pleuronectes platessa</i> | ·914 |
| <i>Clupea sprattus</i> | ·990 |

(7) The following mixtures of Kleinenberg's picro-sulphuric acid were tried:—

| | | | | | | |
|---------------------------|---|---|-------------|---|---|---|
| Picro-sulph..... | 1 | } | 4 per cent. | } | 2 | 1 |
| Alcohol..... | 0 | | | | 2 | 2 |
| 2-per-cent. acetic acid.. | 3 | | | | 2 | 1 |

The results in all cases were unsatisfactory. When the two parts of 4-per-cent. acetic were used the ova (*Trigla gurnardus*) were considerably distended.

(8) Very satisfactory results were obtained with 50-per-cent. alcohol. The shrinkage was small, the oil-globule, however, was indistinct; the dense opacity is also a disadvantage.

(9) Perenyi's fluid stained the eggs a very dark violet. Diluted with 8 parts of 50-per-cent. alcohol very satisfactory results were obtained. The shrinkage averaged ·1371 millim., and the embryo in all the species experimented with showed well.

When ova were not permanently required they were allowed to remain in a 2-per-cent. solution of acetic acid, or 4 parts of the same to 2 parts alcohol and 1 part Perenyi's fluid; both mixtures gave good results. When the embryos were well advanced they were allowed to remain in the former medium until considerable distension took place—about one hour or less. No effect was noticed upon the embryo until four or five hours.

In conclusion, it will be seen that the most satisfactory results were obtained by killing in the picro-hydrochloric acid and preserving in method 6.

XXVII.—On *Eretmotus* and *Epiechinus* (Histeridæ).

By G. LEWIS, F.L.S.

[Plate XIX.]

LAST spring I made another excursion in Algeria, and, searching diligently as occasion offered for Myrmecophilous Histeridæ, I succeeded fairly well as regards *Eretmotus*; but I was not so fortunate in respect to *Sternocælis* as during a somewhat similar ramble in 1888. I found three new-species of *Eretmotus* and one new *Sternocælis*; and my additional material makes it clear that an *Eretmotus* I took in 1888 and erroneously referred to *E. approximans*, Fairm., is an undescribed species.

The best specific characters in *Eretmotus* lie in the structure of the prosternum, and figures of this part of seven species are given here. In the figures the anterior lobe of the prosternum is not shown, the suture before the keel being the limit of the drawing. The Plate also gives some outlines of the sterna of three species of *Epiechinus*, a genus lately formed to receive *Onthophilus costipennis*, Fähr., and allies. The genus at present contains, besides five African species, four from Asia, viz. *E. arboreus*, Lew., *taprobanæ*, Lew., *birmanus*, Lew., and *Onthophilus hispidus*, Mars.; and the structure of the sternal plates is very curious. *O. hispidus*, Mars., is described in the 'Abeille,' i. 1864, p. 340, from specimens taken in Celebes by Wallace, a species supposed by Marseul to be Paykull's *Hister hispidus* from the "East Indies:" but this is more than doubtful. Figure 9 is drawn from an example taken lately at Port Darwin by Mr. J. J. Walker, and is, I think, Marseul's species, the type of which I examined in Paris last May.

On a general study of the Histeridæ, made with such knowledge as I have derived from the habits of about one hundred and fifty species I have seen alive in various parts of the globe, it appears that the elytral striæ serve for what may be termed *guiding-lines*—that is, that a species whose habits do not necessarily constrain it to move in a direct or straight line is guided in its movements or receives assistance in going straight from the dorsal-striæ. The genera *Hister* and *Platysoma*, especially the cylindrical species, contain types of this kind, and *Teretrius* and *Tryponæus* consist of species without striæ, and with them no guiding-lines are necessary, as the species all frequent holes drilled in timber by wood-boring beetles, where they cannot move to the right or to the left. *Eretmotus* is another instance, but of a different kind,

where guiding-lines are not wanted, and the striæ are again almost obsolete; it lives in ants' nests under stones, and while the insect is in the nest it wanders about within the limit of the burrows in any direction without forcing a cavity for itself. When the stone is raised *Eretmotus* moves as fast as possible to the edge of a gallery deeper down in the nest, and then, drawing the legs into the sternal grooves, voluntarily tumbles into it and often feigns death at the bottom. Both classes of insects fly to the places where they congregate, and during flight it does not seem that striation can serve a purpose. The habits of *Sternocælis*, also a genus without striæ, correspond in many ways to those of *Eretmotus*; but it is much more dependent on the ants than the other, and, being so, it is to a greater extent unfettered by the external influences which seem to mould into a monotonous similarity the species in the extensive genera *Hister* and *Saprinus*. During its dependency on the ants *Sternocælis* seems to have been free to develop into strange forms, or, at any rate, forms which appear to us fantastic, almost at random, like *Paussus*; but both *Sternocælis* and *Eretmotus* are limited in their distribution to the area inhabited by their host *Aphanogaster*, while *Paussus*, associating with ants of various kinds, some arboreal, some terrestrial, has been found in every continent.

In the Stercoraceous Histeridæ striæ are useful provided my estimate of their value is correct, as they all burrow more or less in the ground, and a large number of the Coprophaga are also provided with somewhat similar striæ. Amongst the Geodephaga *Abax* is an instance of an insect with guiding-lines, and *Oödes*, like so many aquatic species, is without them. In the *Dytiscus* ♂ there is a resemblance to *Oödes*, and in the female there is a similarity to *Abax*, and perhaps the striation, if there is any analogous use for it in such apparently different insects, is useful to the female when burrowing in the banks of ponds at the time she arranges for the lodgment of her eggs. The Hololeptini are flat and formed for working in all directions under loosened bark, and in several species, such as *Hololepta procera*, Er., and *elongata*, Er., the striæ are as obsolete as in *Eretmotus*, whose movements are similarly free. In the genus *Lioderma* (scarcely separable from *Hololepta*) the species are not all subcortical, but are found in the rotting limbs of the *Opuntia* and similar vegetals, and they have frequently one complete stria, and those which are interrupted are deep. Finally, reference may be made to *Abræus* and *Acrītus*, insects without striæ, and whose habits lead them to roam freely in *Cossus*-burrows or under seaweeds on the shore. The Sapriini have a different dorsal sculpture, but, as

sand-burrowing species, the prominent prosternal keel is without doubt very useful.

1. *Eretmotus corpulentus*, sp. n. (Pl. XIX. fig. 1.)

Orbicularis, convexus, niger, nitidus; pedibus, ore, antennisque rufopiceis; corpore subtilissimo punctato, prosterno striis, antice evanescentibus, basi divaricatis.

L. $3\frac{1}{2}$ mill.

Orbicular, convex, black, shining; the head carinate at the sides, feebly punctulate; the thorax finely punctulate, anterior angles less produced than in *E. Lucasi*, much less produced than in *E. cirtensis*, posterior fovea shallow; the elytra with all the striæ short and nearly obsolete; propygidium and pygidium finely punctulate; the prosternum wide, with the striæ well-marked at the base, widening out behind the coxæ, anteriorly evanescent before the suture, punctuation fine and scattered.

This species is the largest of the series and is very distinct; it comes nearest to *E. Lucasi*.

Found in the plain of Metija.

2. *Eretmotus Lucasi*, Mars. (Pl. XIX. fig. 2.)

On the 29th April, and again on the 4th May, I obtained this species just below the cedar-forest on the mountain above Blida. This is probably the same locality in which Lucas found the first specimens in 1857; the locality given by Marseul is Médéah. The figure is from a specimen I have compared with the type.

3. *Eretmotus cirtensis*, sp. n. (Pl. XIX. fig. 3.)

Suborbicularis, convexus, niger, nitidus; corpore modice punctato; prosterno striis fortibus ad basin divaricatis, sparse punctato.

L. $2\frac{3}{4}$ mill.

Suborbicular, convex, black, shining, nearly smooth above; the head feebly impressed before the clypeus, punctures sparse and shallow, bicarinate; the thorax feebly punctured, anterior angles obtusely produced, with a well-marked fovea within the basal angle; the elytra sculptured like the thorax, epipleural carina well defined, striæ feeble, first one third the length of the elytron, second two thirds, third a little longer than the first; the propygidium and pygidium finely punctulate; the prosternum a little rugose, with scattered shallow punctures, the striæ well marked and widened out at the base, anteriorly continuing to the suture. The prosternal striæ are

nearer to each other in this species than in any other known, and the general outline is less orbicular.

I obtained a small series of this species in the fir-woods above Constantine and a single example at Bone, on the road to La Calle and Guelma.

4. *Eretmotus sociator*, Coq. (Pl. XIX. fig. 4.)

The figure is drawn from an example kindly given to me by Mons. L. Bedel, and is from Daya. The thorax is more transverse than in the other species and the prosternal punctures are distinctly ocellate, as shown in the Plate. Coquerel says nothing about the prosternum, except that it is "saillant;" but Marseul redescribed the species from an example in Fairmaire's collection, and in the diagnosis he says "prosterno dense punctato," and in the text following "prosternum rugueux." Coquerel studied this species so slightly that he made a genus for it, although he knew of Marseul's genus *Eretmotus*, and even writes about it and says it has a certain analogy to *Eretmotus*, and differs in the relative width of the mesosternum—and this it does not do. The species has frequently been assigned erroneously to Fairmaire. I have no doubt about the identification of this species, yet Coquerel speaks of the "thorace elytrisque subtilissime punctatis;" but under the microscope the thorax is strongly punctate, especially at the sides, where the punctures are often ocellate.

5. *Eretmotus kabyliæ*, sp. n. (Pl. XIX. fig. 5.)

Orbicularis, convexus, niger, nitidus; capite ocellato-punctato; thorace lateribus vix dense punctato; prosterno carinis modice punctato sinuatis.

L. $2\frac{3}{4}$ mill.

Orbicular, convex, black, shining, the legs and antennæ, like all the species, rufo-piceous; the head rather densely punctured, feebly impressed before the clypeus; punctures ocellate or subocellate, lateral carina rather strong, feebly sinuous, the thorax somewhat densely punctured at and behind the anterior angles and behind the head, punctures gradually becoming fine and scattered towards the disk; anterior angles moderately produced; posterior fovea shallow and somewhat triangular; the elytra finely punctulate throughout, first and second striæ visible for two thirds of elytra, third obsolete; epipleural carinæ not markedly raised; propygidium and pygidium finely punctulate. The prosternum, striæ widened

out slightly at the base, somewhat parallel to each other laterally, and well marked but shortened before the suture; the punctuation rather large, somewhat scattered, and not ocellate.

I found this at Hamman Rirha, 26th February, 1888.

6. *Eretmotus Bedeli*, sp. n.

Orbicularis, convexus, niger, nitidus; capite subocellato-punctato; pronoto antice punctato; prosterno dense punctato.
L. 2½ mill.

Orbicular, convex, black, shining; the head somewhat closely punctate, punctures ocellate or subocellate, carinæ well marked; the thorax rather densely (not so densely as in *E. kabyliæ*) punctured behind the neck and at and behind the anterior angles; basal fovea very shallow and transverse, the elytra finely punctulate, first stria fine but apparently complete, second dimidiate, third obsolete; the propygidium and pygidium finely punctulate. The punctures on the prosternum are very similar to those of *E. sociator*, but the carinæ are stronger near the base and the anterior mesosternal margin is wider and less angulate.

The prosternum of this species is not figured; the upper surface of the insect is similar to *E. kabyliæ* and beneath it resembles *E. sociator*.

My friend M. L. Bedel discovered this species a few years since in the forest at Teniet el Had, and last May I took four or five specimens in the locality he directed me to.

7. *Eretmotus Leprieuri*, Mars. (*approximans*, Fairm.).
(Pl. XIX. fig. 6.)

I found this species at Hamman Meskoutin, in the cedar-forests above Blida, and at Teniet el Had. It associates with *Aphanogaster striola*, Roger (?), and appears to have a wide area of distribution. The original example was found on Edough, above Bone, and Baron Bonnaire has found it on the "Pic de Cedres," near Batna. The ant is smaller and less black than *A. testaceopilosa*, with the sculpture of the head very rugose and the antennæ and legs brown. At Blida I found six specimens in one nest and at Teniet el Had four together on the 2nd May. At this date *Zygæna zulema*, Pier., was very abundant, but rather worn, and the asphodel and tulip still in bud; but in the valley near Affrville the asphodel was in full flower. The climate of Algeria varies so much from year to year that a statement regarding flowering plants is a better guide to the season than any date.

8. *Eretmotus tangerianus*, Mars. (Pl. XIX. fig. 7.)

I have Marseul's type of this species, but the drawing has been made from a more recent specimen I took at Tangier. The prosternal striæ are very short.

Salient Characters of the Species.

E. corpulentus.—Broad and robust; punctures throughout extremely fine.

E. Lucasi.—Less robust; punctures throughout more distinct.

E. cirtensis.—Inclined to be oblong; prosternal striæ closer together and clearly reaching the suture.

E. sociator.—Thorax transverse; prosternum thickly covered with ocellate punctures.

E. kabyliæ.—Thorax densely punctured externally; prosternal striæ sinuous rather than divergent.

E. Bedeli.—Very similar above to *kabyliæ*; prosternum closely resembles the figure given for *sociator*, Coq.

E. Leprieuri.—A small species with short rugose prosternum. The only species not found with *Aph. testaceopilosa*.

E. tangerianus.—Prosternal striæ nearly obsolete.

EPIECHINUS.

All the members of this genus are more or less squamous, and to show the sculpture of the sterna given in the figures the scales have been carefully removed.

EXPLANATION OF PLATE XIX.

Fig. 1. *Eretmotus corpulentus*, Lew. The prosternal plate without the anterior lobe.

Fig. 2. *Eretmotus Lucasi*, Mars. The prosternal plate without the anterior lobe.

Fig. 3. *Eretmotus cirtensis*, Lew. The prosternal plate without the anterior lobe.

Fig. 4. *Eretmotus sociator*, Coq. The prosternal plate without the anterior lobe.

Fig. 5. *Eretmotus kabyliæ*, Lew. The prosternal plate without the anterior lobe.

Fig. 6. *Eretmotus Leprieuri*, Mars. The prosternal plate without the anterior lobe.

Fig. 7. *Eretmotus tangerianus*, Mars. The prosternal plate without the anterior lobe.

Fig. 8. *Epiechinus birmanus*, Lew. The three sternal plates.

Fig. 9. *Epiechinus hispidus*, Mars. The three sternal plates.

Fig. 10. *Epiechinus taprobanæ*, Lew. The three sternal plates.

XXVIII.—*Descriptions of Thirteen new Species of Terrestrial and Freshwater Mollusca from South Africa.* By JAMES COSMO MELVILL, M.A., F.L.S., and JOHN HENRY PONSONBY, F.Z.S.

[Plate XIII.]

IN continuation of our last paper (*vide* Ann. & Mag. Nat. Hist. 1892, vol. ix. p. 94) we now have the pleasure to present a fifth contribution, which shows how energetically our various correspondents and friends are working in the cause. We may add that we have in preparation a special paper dealing with new forms of the genus *Ennea* and other Pupidæ.

1. *Helix* (*Ærope*) *Trimeni*, sp. n. (Pl. XIII. fig. 1.)

H. testa profunde umbilicata, brunnea, depresso-orbiculari, solidiuscula, supra sericea, confertim striato-costulata, ad basin nitida, sublævi, striis obscuris, spira modice exserta; anfractibus quatuor, ultimo rapide accrescente; apertura rotundo-lunari; peristomate simplici, ad basin et marginem columellarem paulum reflexo. Long. 17, lat. 22 mill.

Hab. "S. Africa" (*R. Trimén*).

A large species of dull brown colour allied to *H. (Ærope) eumacta*, described in this paper, and forming a link between the *caffra* and *vernica* sections.

In general aspect this species is more akin to *caffra*, but the polished base recalls *vernica*, *bullacea*, &c.

We have no exact record of its locality. There are three specimens, of which one is immature.

2. *Helix* (*Ærope*) *eumacta*, sp. n. (Pl. XIII. fig. 4.)

H. testa umbilicata, compacta, solidiuscula, albida, semipellucida, undique epidermide corneo-olivacea, radiatim disposita, induta, globulosa; anfractibus quatuor, convexis, confertim longitudinaliter tenuistriatis, ad suturas depressis, ultimo ad basin viridi-suffuso; apertura lunari-ovata, intus lactea; peristomate tenui, simplici, apud umbilicum triangulatim reflexo. Long. 24, lat. 30 mill.

Hab. Natal (*Crawford*).

A large conspicuous compact shell, of thicker substance than *H. (Ærope) caffra* (Reeve), with the whorls not so elegantly striated, nor so effuse as regards the aperture.

Two specimens.

3. *Helix* (*Macrocyclus*) *cænotera*, sp. n.
(Pl. XIII. fig. 2.)

H. testa profunde umbilicata, declivi, depressa, viridescenti-cornea, tenui, nitidiuscula; anfractibus quinque, supra striis irregularibus dense cingulatis, ad basin nitidioribus; apertura obliquo-lunari; peristomate simplici, tenui.

Long. 10, lat. 17 mill.

Hab. "S. Africa" (*R. Trimen*); Tharfield (*Dr. Schönland*).

From the sources above mentioned we have received six specimens of this species, which have been allocated to *Macrocyclus* because of its general resemblance to *H. van-couverensis*, Lea. This has been done on conchological grounds only, for we have no opportunity of examining the animal.

4. *Helix* (*Macrocyclus*) *liparoxantha*, sp. n.
(Pl. XIII. fig. 3.)

H. testa profunde umbilicata, tenui, nitida, oblique orbiculari-depressa, aureo-cornea; spira obtusa; anfractibus quinque, conspicue regulariter costo-striatis, ultimo anfractu ad basin impresso-excavato; apertura ovata; peristomate tenui, simplici.

Long. 12, lat. (sp. majoris) 18.50 mill.

Hab. Maritzburg (*Burnup*).

Four specimens. This very beautiful shell is allied to *H. cænotera*, just described, but is of a finer build altogether, not quite so obliquely depressed, of a brighter shiny golden colour; umbilicus as deep, but narrower, and the two shells cannot well be confounded when seen together.

5. *Helix* (*Pella*) *actinotricha*, sp. n.
(Pl. XIII. fig. 5.)

H. testa obtecte sed profunde umbilicata, superne planato-depressa, pellucida, cornea, tenui, apice turbinato; anfractibus quinque, ad suturas impressis, convexiusculis, undique epidermide cornea connectis, striato-liratis, ultimo setis quadricingulato (setis ad et infra peripheriam longis, ad basin brevioribus, circa umbilicum denique brevissimis); apertura semilunari; peristomate tenui, columellari ad basin angulato, apud umbilicum triangulatim reflexo.

Long. 5.50, lat. 9 mill.

Hab. Maritzburg (*Burnup*).

A most attractive little species, perhaps not quite adult; of a delicate horny substance and colour, very flattened at the

periphery and above, and with the apex of the last whorl somewhat turbinate; the whole shell covered with a pale horny epidermis, everywhere striato-lirate. Around the periphery most of these striæ bear long bristles or setæ, which extend round the shell; just below also a second series occurs, and further towards the base are two more series, one with very short setæ about midway and the other nearer the umbilicus; in this the bristles are shorter still. We know no species at all nearly resembling this.

Two specimens.

6. *Helix* (*Pella*) *Burnupi*, sp. n.
(Pl. XIII. fig. 6.)

H. testa profunde sed anguste umbilicata, depressa, fusco-cornea, sericea, tenui, semipellucida; anfractibus quatuor, convexis, undique confertim oblique longitudinaliter costoso-plicatis, ad suturas compressis, ultimo compresso, subtus semiconvexo; spira depressa, apice obtusato; apertura obliquo-lunari, tenui; peristomate simplici, apud umbilicum reflexo.

Long. 5, lat. 7 mill.

Hab. Cope's Folly, near Maritzburg (*Burnup*).

More depressed than *H. biscalpta* (Benson), but of allied character, the whorls being very finely obliquely costoplicate, compressed at the sutures, the somewhat oblique mouth thin, reflected at the columellar margin near the umbilicus, which is deep, but narrow.

Several specimens.

7. *Helix* (*Pella*) *conisalea*, sp. n. (Pl. XIII. fig. 7.)

H. testa semipellucida, tenui, anguste umbilicata, albida, orbiculato-depressa, spira convexa; anfractibus quinque, convexis, angustis, ultimo mox accrescente, longitudinaliter dense liratis, et undique epidermide sericeo-setosa tenuissime contextis, setis brevibus regulariter apud liras locatis, et ita dispositis ut lineæ quasi transversæ videantur; apertura lunari-oblonga, patula; peristomate tenui, membranaceo, apud marginem columellarem reflexo.

Long. 5, lat. 6.50 mill.

Hab. Maritzburg (*Burnup*).

A little shell with the aspect of the British *H. hispida*, L., or *sericea*, Müll., but when examined with a lens the whole pellucid surface is seen to be covered with a delicate epidermis, and upon the longitudinal liræ are ranged with regular precision crowded short setæ, so straightly disposed as to give the effect of transverse lines. The whorls are convex, five in number; umbilicus small, lip thin, reflexed at the columellar

margin over the umbilicus. Superficially the shell has a dusty appearance, suggesting the trivial name (*κονισάλεος*). Several specimens.

8. *Helix (Pella) minythodes*, sp. n.
(Pl. XIII. fig. 8.)

H. testa angustissime sed profunde umbilicata, globoso-depressa, lævi, parum nitente, cornea; anfractibus quatuor, obscure striatis, ultimo mox accrescente, subconvexis, ad suturas compressis; apertura lunari-ovata; peristomate tenui, apud marginem columellarem triangulatim reflexo.

Long. 8, lat. 11 mill.

Hab. Craigie Burn (*Lightfoot*).

A neat horn-coloured shell, with a very thin, almost smooth epidermis, without gloss; whorls depressed, very obscurely striated; peristome thin, triangularly reflexed over the umbilicus, which is very narrow but deep; mouth slightly squamose at the base.

Three specimens.

9. *Helix Farquhari*, sp. n. (Pl. XIII. fig. 9.)

H. testa minima, umbilicata, tenui, cinereo-cornea; anfractibus quatuor, undique longitudinaliter scrobiculato-rugosis, gradatulis, ventricosulis, apice papillari; apertura rotundata; peristomate tenui, simplici.

Long. 2, lat. 3 mill.

Hab. Port Elizabeth (*Farquhar*).

A very minute though interesting species, somewhat recalling the *H. rupestris* (Fér.) of Great Britain and Europe. The surface is ashy corneous, irregularly wrinkled with oblique lines longitudinally; whorls four, somewhat angled, and simple mouth.

10. *Vitrina fuscicolor*, sp. n. (Pl. XIII. fig. 10.)

V. testa ampla, orbiculari-depressa, fusco-brunnea, tenui, spira subconica, ad apicem albescente; anfractibus quatuor, lente accrescentibus, longitudinaliter oblique striatis, transversim irregulariter unduloso-rugosis; apertura lunari-ovata, ampla; peristomate tenuissimo, margine membranaceo.

Long. 15, lat. 23 mill.

Hab. Rensberg's Kop, an offshoot of the Drakensberg, at an elevation of 7000 feet (*Quekett*).

A remarkable shell, and one very dissimilar from any species of the genus known to us from S. Africa, being of a warm russet-brown colour, with superficial shagreened, almost

silky appearance, owing to the indistinct irregular cross-lineation all over the surface. The apex is white; the whorls are four in number, somewhat gradually increasing; mouth large, but not so effuse as in some species; margin of lip membranaceous. The epidermis is slightly iridescent.

Six specimens.

11. *Vitrina chrysoprasina*, sp. n. (Pl. XIII. fig. 11.)

V. testa conico-globosa, pellucida, viridi-cornea, tenuissima; anfractibus quatuor, ventricosulis, undique longitudinaliter obscure striatis, ultimo mox accrescente; apertura lunari-rotundata, apud marginem columellarem paulum reflexa.

Long. 10, lat. 11 mill.

Hab. Pretoria.

This very beautiful conical little species is of very delicate substance and rounder than *V. natalensis* (Krauss); there is also no sign of any peripheral red band. Since we first received a specimen from Pretoria, in the spring of this year, the species has been shown to us from no less than three separate quarters—Mr. Heathcote, of Preston, and Mr. Standon, of Manchester, both having specimens sent by their South-African correspondents, and Mr. Sowerby likewise supplying us with the same shell.

12. *Vitrina phædima*, sp. n. (Pl. XIII. fig. 12.)

V. testa depresso-orbiculari, apice modice exserto, nitidissima, læte cornea; anfractibus quatuor, convexulis, ultimo in medio anguste et inconspicue rubri-cingulato, ad suturas subimpressis, lævissime irregulariter plicato-striatis; apertura lunari-oblonga.

Long. 8, lat. 12 mill.

Hab. Maritzburg (*Burnup and Quekett*).

This species somewhat resembles *V. pellicula*, Fér., but is of more transparent substance and brighter golden-horny colour, with a thin red band encircling the last whorl, this being very inconspicuous in some specimens. It is one of the most beautiful of the South-African species.

Several specimens. One of them is remarkably planate and may prove to be a distinct species; we prefer, however, awaiting the arrival of further specimens before deciding.

13. *Planorbis (Segmentina) emicans*, sp. n.

(Pl. XIII. figs. 13, 13 a.)

P. testa depressa, nitida, læte fulvescente, lævissima, spira depplanata; anfractibus tribus, ultimo rapide accrescente, ad basin

expanso, subangulato; apertura obliquo-trigionali; peristomate simplici.

Long. 2.50, lat. 1.75 mill.

Hab. Zwartkop (*Farguhar*).

This very pretty species is not unlike the British *P. nitidus* (Müll.).

EXPLANATION OF PLATE XIII

Fig. 1. Helix Trimeni.
Fig. 2. — cænoteru.
Fig. 3. — liparoxantha.
Fig. 4. — eumacta.
Fig. 5. — actinotricha.
Fig. 6. — Burnupi.
Fig. 7. — conisalea.

Fig. 8. Helix mynthodes.
Fig. 9. — Farguhari.
Fig. 10. Vitrina fuscicolor.
Fig. 11. — chrysoprasina.
Fig. 12. — phædima.
Figs. 13, 13 a. Planorbis emicans.

XXIX.—On *British Mysidæ*, a Family of Crustacea Schizopoda. By the Rev. Canon A. M. NORMAN, M.A., D.C.L., F.R.S., &c.

[Continued from p. 166.]

Genus 7. LEPTOMYSIS, G. O. Sars, 1869.

Eyes subglobose, not compressed. *Antennal scale* subulate, ciliated all round, second joint very long and running out to a narrow extremity. *Legs* long and slender; tarsus 3-articulated; a very slender nail. *Telson* linguiform or lanceolate, of considerable size, margins spined, entire at the extremity, which is aculeated with spines of unequal length. *Uropods* long and narrow, ciliated on all sides; acoustic organ large. *Pleopods* in female one-jointed, small and narrow; in male well developed, biramose, multiarticulate, natatory; lateral basal lobe of inner branch small; outer branch of fourth pair having 1-3 terminal articulations furnished with ciliated spines (instead of setæ).

1. *Leptomysis gracilis*, G. O. Sars.

1864. *Mysis gracilis*, G. O. Sars, Beret. om en i Somm. 1863 foretagen Zool. Reise i Christiania Stift, p. 23.
 1869. *Mysis hispida*, Norman, "Last Report Dredging Shetland Isles," Brit. Assoc. Rep. 1868, p. 267.
 1869. *Leptomysis gracilis*, G. O. Sars, Undersøgelser over Christianiafjordens Dybvandsfauna, p. 29.
 1879. *Leptomysis gracilis*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 31, pls. xix., xx.
 1882. *Leptomysis gracilis*, Czerniavsky, Monogr. Mys. Imp. Ross. fasc. i. p. 90, iii. p. 20.

Form slender and elongate; pellucid and almost colourless, except some rosy-coloured blotches at the base of the pleopods; cephalothorax scarcely wider than the unusually long pleon; dermis everywhere (even to the eyestalks and antennules) hispid, with minute scales. *Rostrum* broadly triangular, large, acutely pointed at extremity, reaching beyond the middle of the first joint of the antennules; a notch on front margin on each side of the base of the rostrum over the insertion of the eyes. *Eyes* pyriform, very narrow at the base, and much widening, projected greatly beyond the sides of the cephalothorax. *Antennules* with a long and slender peduncle; first joint hollowed on upper surface, long and slender, the two following much thicker, their combined length equal to that of first. *Antennal scale* very long, narrowly lanceolate (or subulate), twice as long as the long peduncle of the antennules and about nine times as long as the greatest breadth at the base; second joint occupying nearly one third of total length, extremely narrow, furnished with five setæ on each side and one terminal. *Legs* very slender, the 3-articulated tarsus not longer than the preceding joint; nail very long and slender. *Telson* elongated, narrowly linguiform, shorter than inner uropods, constricted near the base, beyond which the sides are gently arched; margins throughout furnished with crowded spines, which towards the extremity are ranged in series of three or four of gradually increasing length; apex narrowly rounded, bearing four spines, the inner pair of which are about two thirds the length of the outer. *Uropods* very narrow, the outer very long, one third longer than the inner; inner swollen at the base, where the otolith is large, bearing a large spine at the extremity itself, and a range of spines of unequal size and irregular arrangement all along the inner margin. Length 13 millim.

Hab. A single male was dredged by me in 40–50 fath. five to seven miles off Balta, Shetland, in 1867. Shortly afterwards both sexes were sent to me by T. Edward from Banff. Moray Firth and Firth of Forth (*T. Scott*): *Mus. Nor.*

Distribution. Sars has taken this species in the Christiania Fiord, at Stavanger, and at Mosterhavn in the Hardanger Fiord, in 10–40 fath. (*Mus. Nor.*). Boulonnais, France (*Giard*).

The hispidity of the dermis of *L. gracilis* distinguishes it at a glance from its allies.

2. *Leptomysis mediterranea*, G. O. Sars.

1876. *Leptomysis mediterranea*, G. O. Sars, Nye Bidrag til Kundskaben om Middelhavets Invertebratfauna, I. Middelhavets Mysider, p. 27, pls. xix., xx., xxi.

1882. *Leptomysis mediterranea*, Czerniavsky, l. c. fasc. i. p. 90, ii. p. 21.

1885. *Leptomysis mediterranea*, Carus, Prod. Faun. Medit. p. 467.

General form very slender and narrow and produced; cephalothorax scarcely wider than the pleon, everywhere adorned with arborescent brown pigment markings, which on the pleon, as seen from above, present to the naked eye two blotches on each segment, and at the base of the telson two dark spots. *Rostrum* largely developed, elongate-triangular or conical, extending to the end of the first joint of the peduncle of the antennules. *Eyes* clavate, but not much constricted at the base. *Antennal scale* of extraordinary length, nearly three times as long as the peduncle of the antennules, narrowly lanceolate, length equal seven to eight times the greatest breadth; second joint very distinctly articulated, very long, fully one third of total length, with nine to twelve setæ on each side and one terminal; all the setæ of the antennal scale are shorter than usual. *Telson* linguiform, more than twice as long as the greatest breadth of the base, only slightly constricted near the base; extremity widely rounded (but not nearly so broad as in *L. lingvura*); margin with very numerous spines of unequal length, which towards the extremity arrange themselves in sets of four or five; middle of extremity with a pair of long spines and two (varying from two to four) much smaller spines between them. *Inner uropods* longer than the telson; otolith not very large; inner margin with numerous (about thirty to forty) spines, which are small, and very crowded near the base, but increase in length distally, the last spine being very long and situated just before the end of the uropod. Length 15–16 millim.

Hab. Taken by me in great abundance at Guernsey in 1865, and remaining with a MS. name in my collection until it was described by Prof. Sars. I have since obtained it at Jersey, and Starcross, Devon.

Distribution. Adriatic (*Claus*). When at the Zoological Station at Naples in 1887 I found this species to be very abundant in the Bay: *Mus. Nor.* Sars has found it at Goletta, Syracuse, and Spezia. Arenys de Mar, Spain (*Antiga*, fide *de Buer*).

The great development of the second joint of the antennal scale enables this species easily to be separated from all other *Mysidæ*.

3. *Leptomysis lingvura*, G. O. Sars.

- † 1842. *Cynthia Flemingii*, H. Goodsir, Edin. New Phil. Journ. vol. xxxiii. p. 175, pl. ii. fig. 1.
 † 1850. *Cynthia Flemingii*, Bell, Brit. Stalk-eyed Crust. p. 379.
 † 1850. *Cynthilia Flemingii*, Gray, List Specimens of Brit. Anim. in B. M., Crustacea, p. 46; White, Pop. Hist. Brit. Crust. p. 147.
 1866. *Mysis lingvura*, G. O. Sars, Beret. om i Somm. 1865 foretagen Reise, p. 21.
 1876. *Leptomysis sardica*, G. O. Sars, Middel. Mysider, p. 46, pl. xxxvi.
 1879. *Leptomysis lingvura*, G. O. Sars, Carcin. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 35, pl. xxi.
 1882. *Leptomysis pontica*, Czerniavsky, l. c. fasc. i. p. 91, fasc. iii. p. 21, pl. viii. figs. 1-24, pl. ix. figs. 1-13.
 1882. *Leptomysis lingvura*, Czerniavsky, l. c. fasc. i. p. 90, fasc. iii. p. 22.
 1883. *Leptomysis sardica*, Czerniavsky, l. c. fasc. iii. p. 21.
 1886. *Leptomysis lingvura*, Norman, Fourth Ann. Rep. Fish. Board of Scotland, p. 159, and Ann. & Mag. Nat. Hist. ser. 5, 1887, vol. xix. p. 94.

In general form this is much shorter than the last two species, the dermis not hispid, the animal not so pellucid, but stained with yellow and having two black dendritic spots at the termination of the sixth segment of the pleon, from whence the colour branches down into the telson. *Rostrum* not much produced, shortly triangular, acute at the apex, shorter than half the length of the basal joint of the antennules; no notch on the front margin of the cephalothorax over the eye. *Eyes* shorter than in *L. gracilis* and not so very much contracted at the base. *Antennules* with basal joint hollowed above, subequal in length to the two following joints. *Antennal scale* almost exactly as in *L. gracilis*, except that the second joint is somewhat shorter, occupying scarcely one fourth of the total length, with four or five setæ on each side and two terminal. *Telson* shorter than the inner uropods, linguiform, extremity remarkably broad and widely rounded, and occupied by four long spines and two, three, or four shorter spines in each interval between them; margins of telson furnished with very numerous densely-set spines, usually of rather unequal length towards the extremity. *Inner uropods* much shorter than the outer (as about 2 to 3); otolith large; beyond the otolith the uropod is narrower and bears no spine at the extremity, but the inner margin is edged with very numerous spines throughout its length, the spines opposite the otolith being much smaller, slender, and crowded. Length 17 millim.

Hab. This species has been known to me as a member of the British fauna for the last twenty-six years, at which time I took it abundantly between tide-marks at Cullercoats,

Northumberland, and within a year or two afterwards at Howden and Seaham Harbour on the Durham coast. It has also been procured for me at Starcross, Devon, by Mr. C. Parker, and I took it in 1889 at Plymouth: *Mus. Nor.* In 1885 Mr. G. Brook sent me a specimen to determine from Tarbert, Loch Fyne. I have always considered it to be the "*Cynthia Flemingii*, H. Goodsir," although his description is very inexact. It is evident from his description of the antennal scale that he had no true *Siriella* (= *Cynthia*) before him, but the account is not sufficiently accurate to allow of his name being adopted.

Distribution. Florø, Norway, 10-12 fath.; Naples (*A. M. N.*); Adriatic (*Claus*): *Mus. Nor.* Farsund, 10-12 fath.; Moldö and Aalesund, Norway; Cagliari, Mediterranean (*G. O. Sars*); Black Sea (*Czerniavsky*); Boulonnais (*Giard*).

A *Leptomysis* has been described from the Mediterranean under the names *Leptomysis sardica*, G. O. Sars, and *Leptomysis pontica*, Czerniavsky, which it appears to me cannot be separated specifically from the northern *Leptomysis lingvura*, G. O. Sars. The fact is that the telson is subject to very considerable variation in northern and Mediterranean specimens. That *L. lingvura* occurs in the Mediterranean basin is certain, as some unnamed Mysidæ sent to me by Prof. Claus from the Adriatic unquestionably belong to that species. *Leptomysis sardica* I took at Naples in 1887. The specimens were very much smaller than *L. lingvura* as found in the north, and some only 7 millim. long have the marsupial pouch fully developed; the telson of some of these closely agreed with Sars's figure, but there was considerable variation (from three to five) in the number of small spines between the central long pair of spines; in other specimens there were one or two more pairs of spines on the sides of greater length than the others. On examining small northern specimens of *M. lingvura* of about similar size I find the spination of the telson closely to accord with that of *L. sardica*, and as the animal increases in size the number of larger spines interspersed among the smaller ones of the lateral margins increases also. It appears to me that *L. sardica* must be regarded as a small race of *L. lingvura*, with which it agrees in all general characters. It is no new thing to find that southern examples of an animal are of smaller size than more northern brethren.

Subfam. V. *MYSINÆ*.Genus 8. *HEMIMYSIS*, G. O. Sars, 1869.

Carapace having part of one or one and part of a second segment of cephalothorax exposed behind. *Eyes* subglobose, peduncles short. *Antennal scale* rather small, shortly lanceolate; outer margin more or less ciliated, no spine. Mouth-organs generally resembling those of *Mysis*, but the *mandibles* with second joint of palp expanded and subovate. *Legs* with 4-5-jointed tarsus, ending in a very slender spine-like nail. *Marsupial pouch* formed of three pairs of laminae, one of which is very small. *Pleopods* in female small, rudimentary: in male, two first pairs rudimentary, third with large basal joint and one branch; fourth very long, styliform, terminating in two filaments; fifth with large basal joint and two multiarticulate, strongly ciliated branches adapted for swimming. *Telson* not large, cleft at the extremity. *Outer uropods* one-jointed, long and narrow, truncate at the extremity, ciliated all round.

The character of the pleopods in the male distinguishes this from all other genera: while the fourth pair are very like the same organ in *Schistomysis ornata*, the third and fifth pairs are wholly different; these are formed for swimming and closely resemble the same pairs in the genus *Leptomysis*. The female may be distinguished from *Mysis* by the mandible-palp, the short antennal scale, and slender nail of the peræopods.

Hemimysis Lamornæ (Couch).

1856. *Mysis Lamornæ*, Couch, 'The Zoologist,' p. 5286.
 1860. *Mysis Lamornæ*, Norman, Ann. & Mag. Nat. Hist. ser. 3, vol. vi. pl. viii. figs. 4, 5.
 1863. *Mysis Lamornæ*, Goës, Crust. decap. podoph. Sueciæ, p. 15.
 1864. *Mysis aurantia*, G. O. Sars, Beret. om en i Somm. 1863 foretagen Zool. Reise, p. 20.
 1879. *Mysis Lamornæ*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 65, pl. xxx.
 1882. *Hemimysis pontica*, Czerniavsky, l. c. fasc. i. p. 117, pl. vii. fasc. iii. p. 48.
 1883. *Mysis aurantia* and *Lamornæ*, Czerniavsky, l. c. fasc. iii. p. 54.

General form short and robust, anterior portion of cephalothorax as broad as or broader than earlier segments of pleon; colour bright red or orange. *Eyes* short but very large, projected only slightly beyond margin of cephalothorax. *Rostrum* very short, obtusely angulated. *Antennules* having the peduncle robust, basal joint equal to the two following. *Antennal scale* elongated-subovate, about three times as long

as wide, only slightly longer than peduncle of antennules; outer margin without any spine, but naked (that is without setæ) on the lower half; from the spot where the setæ commence the margin slopes inwards to the narrowly rounded point, which is subcentral to the length of the scale. *Legs* rather slender; tarsus of 4-6 articulations, the last very slender and terminating in a very slender nail. *Telson* much shorter than inner uropods, gradually narrowing, cleft about one fourth its length, widely open; upper half of sides of telson without spines, distal half with 6-12 lateral spines, the penultimate of which is some distance from the extremity; terminal spines more than usually developed and long, their length often equal to about half the depth of the cleft. *Inner uropods* with 6-10 spines on the inner margin, gradually increasing in length distally and confined to the anterior two thirds of the margin; otolith of moderate size.

Male.—*Pleopods* of first two pairs simple; third pair with large and broad basal joint and a single one-jointed ciliated branch, which gives off a small laterally projected process on the outer side of its base: fourth pair very long, consisting of two basal joints, the second of which is long, and two branches; of these the inner is minute, two-jointed, the first giving off a little lateral process, the second terminating in three setæ; outer branch of great length, basal portion composed of five articulations, of which the first is nodulous below at the extremity, and the third and fourth are subequal in length; the limb terminates in two long filaments, which are ciliated towards the extremities, and the outer about half as long again as the inner: fifth pair formed for swimming, of considerable length, reaching to half the length of telson; basal joint long, branches 4-5-jointed, furnished with long setæ; inner branch with a small lateral projection at the base. Length 8-10 millim.

Hemimysis Lamornæ is a true *Hemimysis*, agreeing in all generic characters with the type *H. abyssicola*, from which indeed it seems to be chiefly distinguished by its more robust form and fewer lateral spines on the telson. It agrees with that species in the broad flattened second joint of the mandible-palp, in the slender nails in which the legs terminate, in the narrow outer uropods, abruptly truncate at the extremity, and above all in the characters of the pleopods in the male. Prof. G. O. Sars, pl. xxx. fig. 13 (Mon. Norges Mys.), figures the fourth pleopod of the male; but, as he correctly states, it must be "*maris junioris*," since it is very different from that of the adult.

Czerniavsky's *Hemimysis pontica* altogether agrees with not quite mature specimens of this species.

Hab. Falmouth, Plymouth (*A. M. N.*); Banff (*T. Edward*); Seaham, co. Durham (*G. Hodge*); Loch Goil (*D. Robertson*); Tarbert, Loch Fyne, and Firth of Forth (*T. Scott*); *Mus. Nor.* Port Glasgow (*D. Robertson*); Colwyn Bay, N. Wales (*A. O. Walker*).

Distribution. When I was at the Zoological Station at Naples I found this species, which had been previously sent to me from the station, breeding in immense numbers in the tanks. Suchum, Black Sea (*Czerniavsky*); Norwegian coast from Christiania to Lofoten (*G. O. Sars*); West Sweden (*Goës*); Denmark (*Meinert*).

Genus 9. MACROPSIS, G. O. Sars.

= *Podopsis*, Van Beneden &c. (P Thompson), = *Parapodopsis* and *Mesopodopsis*, Czerniavsky (subgenera).

Animal very slender; cephalothorax much narrower in front than behind; carapace leaving the two hind segments uncovered, and the central portion of the antepenultimate; in front the rostral portion is slightly produced, rounded, its external angles with a well-developed spine. *Antennules* with greatly produced peduncles; antennal scale subulate, ciliated all round. *Eyes* enormously developed, being elevated on very long and nearly cylindrical stalks, so that the total length of the eye is much greater than the breadth of the front portion of the carapace. *Legs* subequal in length, tarsus multiarticulate, no nail. *Telson* very short, basal portion subquadrate, and the apex triangularly produced and serrated beyond the distal spines of the lateral margins.

Male.—*Antennules* terminating with the usual two filaments, and having besides a very large hirsute lobe (as usual in male Mysidæ) and a fourth appendage consisting of a long narrow, conical, basal process, to the distal extremity of which is attached a single very long seta. *Third pleopods* consisting of a large basal joint and two branches, the inner and larger of one joint, ciliated on the inner margin, the outer much smaller, of two joints. *Fourth pleopods* greatly developed and very like in general form to those of *Schistomysis ornata*: basal joint very long, with two branches—inner minute, one-jointed, with a lateral lobe at the base; outer consisting of three articulations, the second very long, and third short and terminating in two flagella, outer long, many-jointed, inner about one fourth its length, not jointed.

Macropsis Slabberi (Van Beneden).

1778. "Steurgernaal met trompetwijze oogen," Martin Slabber, Natuurkundige Verlustigingen, pl. xv. figs. 3, 4.
 1860. *Podopsis Slabberi*, V. Beneden, Rech. sur la faune litt. de Belgique, Crustacés, p. 18, pl. vi.
 1863. *Mysis Slabberi*, Goës, Crust. decap. podoph. mar. Sueciæ &c. p. 16.
 1867. *Podopsis Slabberi*, Marcusen, "Zur Fauna des Schwarzen Meeres," Archiv für Naturg. 1867, p. 359.
 1876. *Macropsis Slabberi*, G. O. Sars, Middelhavets Mysider, p. 28, pls. xi.-xiii.
 1882. *Podopsis* (*Mesopodopsis*) *Slabberi* and (*Parapodopsis*) *Goësi*, Czerniavsky, l. c. fasc. i. p. 145.
 1882. *Podopsis* (*Parapodopsis*) *cornuta*, id. ibid. p. 149, pls. i., ii., and iii., figs. 1-15.
 1883. *Podopsis Slabberi*, Goësi, and *cornuta*, id. ibid. fasc. iii. pp. 48, 49.
 1885. *Macropsis Slabberi*, Carus, Prod. Faun. Medit. p. 466.

Basal joint of *antennules* subequal in length to rest of peduncle. *Antennal scale* very narrow, subulate, subequal in length to peduncle of antennules, ciliated all round; second joint with a pair of lateral and three terminal setæ. *Telson* short, about one third the length of the outer uropods, exclusive of terminal portion about as long as the breadth at the base; hinder portion of lateral margins with three to seven spines; the extremity of the telson is projected beyond the lateral margin in somewhat triangular form, but the apex is rounded; the entire margin of this terminal portion is serrated. *Legs* having the tarsus composed of seven to eight articulations. *Inner uropods* with a single spinule on the inner margin, a little behind the otolith. *Outer uropods* much longer than inner, narrow, ciliated all round. Length 11-13 millim.

Hab. Granton, Firth of Forth, 1884 (*J. R. Henderson*); Falmouth (*G. C. Bourne*).

Distribution. Naples, 1887 (*A. M. N.*); Bahusia, Sweden (*Lovén*); Belgium (*Van Beneden*); *Mus. Nor.* Denmark (*Meinert*); Holland (*P. P. C. Hoek*); mouth of the Seine (*de Kerville*); in the Mediterranean, at Goletta, Syracuse, and Spezzia (*G. O. Sars*); Black Sea (*Marcusen &c.*); Odessa and Sebastopol (*Czerniavsky*)*.

* The embryology of this species has been studied by Boutchinsky (P.), 'Observations sur le développement de *Parapodopsis cornuta*, Czern.', 1888 (in Russian).

Genus 10. *MACROMYSIS*, A. White* (1847).

= *Themisto*, H. Goodsir, = *Mysidia*, Dana, = *Synmysis* and *Keslerella*, Czerniavsky.

Antennal scale elongated, linear, nearly parallel-sided, four to nine times as long as broad; outer margin naked, terminated by a spine; apex of scale not surmounting or only slightly projected beyond the extremity of this spine. *Legs* with tarsus of four to seven articulations, terminating in a nail. *Telson* cleft at the extremity, cleft serrated. *Fourth pleopod* of male having the inner branch small, two-jointed, the first giving off an outward-directed seta-tipped lobe; outer branch very long and stiliform, consisting of seven gradually attenuating articulations, the terminal one distally verticillately ciliated and bulb-formed at the extremity.

1. *Macromysis flexuosa* (Müller).

1788. *Cancer flexuosus*, Müller, Zool. Dan. vol. ii. p. 34, pl. lxvi. figs. 1-9.
 1803. *Cancer astacus multipes*, Montagu, Linn. Trans. vol. ix. p. 80, pt. ii. fig. 26.
 1815 (?). *Praunus flexuosus*, Leach, Edin. Encycl. vii. p. 401.
 1815. *Mysis spinulosa*, Leach, Linn. Trans. vol. xi. p. 350.
 1828. *Mysis chamæleon*, J. V. Thompson, Zoolog. Researches, i. p. 23, pl. ii. figs. 1-10.
 1828. *Mysis Leachii*, id. ibid. p. 27.
 1844. *Mysis spinulosus*, Zaddach, Synopseos Crust. Prussic. prodromus, p. 2, ♂ ♀.
 1855. *Mysis flexuosa*, Kröyer, Gaimard, Voyage en Scandinavie &c., Crust. pl. ix. figs. 1-3.
 1853. *Mysis chamæleon*, Bell, Brit. Stalk-eyed Crust. p. 336, ♀.
 1853†. *Themisto brevispinosa* (H. Goodsir), Bell, Brit. Stalk-eyed Crust. p. 384, ♂.
 1860. *Mysis flexuosus*, Norman, Ann. & Mag. Nat. Hist. ser. 3. vol. vi. pl. viii. figs. 1-3.
 1860. *Mysis chamæleo*, P. J. Van Beneden, Recher. sur la faune litt. de Belgique, Crustacés, p. 14, pls. ii.-v.
 1861. *Mysis flexuosa*, Kröyer, Nat. Tidsskr. 3die Række, vol. i. p. 2.
 1879. *Mysis flexuosa*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 45, pls. xxiv., xxv.
 1882. *Synmysis flexuosa, chamæleon*, Benedeni, and Meczniukoi, Czerniavsky, l. c. fasc. i. pp. 31. 32.

* A. White, 'List of Crust. in Brit. Mus.' (1847), p. 81; 'Popular History of British Crustacea' (1857), p. 146.

† It seems probable that Goodsir's *Themisto brevispinosa* was the male of this species, but what his *T. longispinosa* was I cannot guess. One thing is certain, that his genus *Themisto*, = *Macromysis*, White, was founded on males of the genus to which I apply the name.

1883. *Synmysis Normani*, *flexuosa*, *chamæleon*, *Benedeni*, *Mecnikowi*, and *spinulosa*, Czerniavsky, l. c. fasc. iii. pp. 58, 64.
 1887. *Mysis flexuosa*, Köhler, "Structure du Cerveau," Ann. Sci. Nat. Zool. sér. 7, vol. ii. p. 150, pls. x., xi.
 1887. *Mysis chameleo*, Nausbaum, "L'embryologie," Arch. de Zool. Expl. et Gén. sér. 2, vol. v. p. 123, pls. vi.-xii.

Antennal scale very long, narrow and linear, more than twice as long as peduncle of antennules, and seven to eight times as long as broad; outer margin naked, terminating in a forward-directed spine, the extreme apex of the scale scarcely overtopping the point of that spine. *Tarsus* of legs six-articulated, of last pair five-articulated, nail well developed. *Telson* having cleft at extremity extending about one sixth of total length of telson, moderately open; about twenty-one to twenty-seven spines on each side of telson. *Inner uropods* with largely developed otolith; inner side with about ten to twelve spines, which are confined to the anterior two thirds of the length and situated within the margin of the under surface; these spines gradually increase in size distally. Length 25 millim.

Hab. *Mysis flexuosa* is found on all parts of our coasts between tide-marks in rock-pools, and in the Laminarian zone.

Distribution. Norway (*G. O. Sars & A. M. N.*); Sweden (*Goës*); Baltic (*Lindström*); Finland (*Cajander*); Denmark (*Meinert*); Holland (*P. P. C. Hoek*); Belgium (*Van Beneden*); France (*Brebisson &c.*). [Black Sea (*Greb-nitzky*)?]*

2. *Macromysis neglecta* (G. O. Sars).

1869. *Mysis neglecta*, G. O. Sars, Undersøgelser over Christianiafjordens Dybvandsfauna, p. 37.
 1879. *Mysis neglecta*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 51, pl. xxvi.
 1882. *Synmysis neglecta*, Czerniavsky, l. c. fasc. ii. p. 26, fasc. iii. pp. 57 and 61.

Very like *M. flexuosa* in all its parts, but distinguished by the following characters:—*Antennal scale* about five times as long as broad and not twice the length of the peduncle of the antennules, its apex slightly more extended, to about twice the length of the spine of the external margin. *Tarsus* of legs five-articulated, of last pair four-articulated. *Telson*

* Grebnitzky (N. A.), Fauna of the Black Sea, 1873 (in Russian). Marcusen (Joh.), 'Zur Fauna des schwarzen Meeres,' also gives *M. spinulosa*, *chameleo*, and *vulgaris*, and *Podopsis Slabberi* as living in the Black Sea.

cleft to about one fifth of its entire length, the cleft very narrow and constricted at the base; margins of telson with eighteen to twenty spines. *Inner uropods* spined almost as in the last, but the otolith is proportionately smaller. Length about 20 millim.

Hab. Jersey; Guernsey; Starcross, Devon; Plymouth (A. M. N.); mouth of Loch Fyne (Dr. Henderson): *Mus. Nor.* North Wales (A. O. Walker).

Distribution. Hardanger Fiord, Norway (A. M. N.); South and West Norway and Lofoten Islands (G. O. Sars); Denmark (Meinert).

3. *Macromysis inermis* (Rathke).

1843. *Mysis inermis*, Rathke, Beiträge zur Fauna Norwegens, p. 20.
 1852. *Mysis inermis*, Lilljeborg, Öfvers. af Vet.-Akad. Förhand. p. 3.
 1861. *Mysis cornuta*, Krøyer, Nat. Tidsskr. 3die Række, vol. i. p. 26, pl. i. figs. 3 a-g.
 1863. *Mysis cornuta*, Goës, Crust. decap. podoph. marina Sueciæ, p. 14.
 1864. *Mysis truncatula*, G. O. Sars, Beret. om en i Somm. 1863 foretagne Zoolog. Reise, p. 16 (*monstrositas*).
 1869. *Mysis inermis*, Norman, "Last Report Dredging Shetland Isles," Brit. Assoc. Rep. for 1868, p. 266.
 1879. *Mysis inermis*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 54, pl. xxvii.
 1882. *Keslerella cornuta*, Czerniavsky, l. c. fasc. ii. p. 36.
 1882. *Keslerella similis*, Czerniavsky, l. c. fasc. ii. p. 38.
 1883. *Keslerella cornuta*, *similis*, *inermis*, *truncatula*, and *Goësi*, Czerniavsky, l. c. fasc. iii. pp. 67-71.

Anterior margin of cephalothorax not produced, widely rounded, and exposing in front of it a sharp triangular spine which springs from between the bases of the antennules; while thus the margin is not rostrately produced as in the last two species, this spine gives the appearance of a rostrum. *Antennal scale* half as long again as the peduncles of antennules and about four times as long as broad; apex produced beyond base of spine of outer margin to two or three times the length of that spine. *Tarsus* of legs consisting of four articulations; nail well developed and stronger than in allies. *Telson* cleft to nearly one third of total length, cleft very narrow; margins of telson with about seventeen spines. *Inner uropods* having few marginal spines, only about six, which, as in the preceding species, gradually increase in size distally. Length about 20 millim.

Hab. Rock-pools, Shetland; Cullercoats, Northumberland; Oban; Plymouth; Guernsey (A. M. N.); Banff (T. Edward); Tarbert, Loch Fyne (Thomas Scott): *Mus. Nor.* Firth of Forth (T. Scott); Isle of Cumbrae (J. R. Henderson).

Distribution. Kors Fiord; Bukken, Bergen Fiord; Lervig and other places in the Hardanger Fiord; Florö,—all in Norway; Klosterelv Fiord, E. Finmark (*A. M. N.*); Baltic Sea (*Lovén*); Bergen (*Lilljeborg*): *Mus. Nor.* Many localities from Christiania to Vadso (*G. O. Sars*); Sweden (*Goës*); Denmark (*Meinert*); Baltic (*Lindström*); Murman Sea (*Jarzynsky*); Spitsbergen (*Kröyer*). It is a shallow-water species.

Genus 11. SCHISTOMYSIS, gen. nov.*

= *Synmysis* (partim) and *Austromysis*, Czerniavsky.

Antennal scale subrhomboidal or lozenge-shaped, length to breadth as $2\frac{1}{2}$ — $4\frac{1}{2}$ to 1; outer margin not ciliated, with a spine-like tooth at the extremity †; the end of the scale very oblique and reaching far beyond this spine-point. *Maxillipeds* not unguiculate. *Legs* having the tarsus 5–9-articulated, terminating in a setiform spine. *Telson* cleft at the extremity, cleft serrated. *Fourth pleopods* in male very long: peduncle and inner ramus as usual in *Mysinæ*; outer ramus composed of five or six ‡ articulations and then divided into two long flagella, both of which are ciliated on the distal portion, the outer the longer.

1. *Schistomysis spiritus*, Norman.

1860. *Mysis spiritus*, Norman, Ann. & Mag. Nat. Hist. ser. 3, vol. vi. p. 431, pl. viii. fig. 1; and Trans. Tyneside Nat. Field Club, vol. iv. p. 329, pl. xvii. fig. 1.
 1866. *Mysis spiritus*, G. O. Sars, Beret. om en i Somm. 1865 foretagen Zool. Reise, p. 19.
 1869. *Mysis spiritus*, Norman, "Last Report Dredging Shetland Isles," Brit. Assoc. Rep. for 1868, p. 266.
 1879. *Mysis spiritus*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 58, pl. xxviii.
 1883. *Synmysis spiritus*, Czerniavsky, l. c. fasc. iii. p. 56.

Form very slender, perfectly hyaline and transparent, almost entirely free from pigment-markings; anterior portion of cephalothorax very narrow, narrower than first joints of pleon. *Eyes* cylindrical, narrow; cornea small, projected outwards and reaching far beyond the sides of cephalothorax. *Antennules* with greatly elongated peduncle, basal joint

* *σχιστός*, cleft, with reference to the two flagella in which the fourth pleopod of male terminates.

† In *Macromysis* the similar process is an articulated spine; in this genus it seems to be not articulated, but a process of the scale itself.

‡ The very short first articulation generally indistinct.

subequal to or rather longer than the two distal combined; flagella unusually short, the outer not half the length of cephalothorax. *Antennal scale* narrow, subrhomboidal, rather longer than the peduncles of the antennules, more than four times as long as broad, one third of total length extended beyond the spine which terminates the outer margin; termination of the peduncle of flagellum reaching that spine. *Tarsus* of legs subequal in length to the preceding joint, slender, composed of 7-9 articulations; no nail. *Telson* constricted near the base, beyond which constriction the sides are gently arched; cleft shallow and broad, scarcely exceeding one sixth of total length of telson, external margins with 25-30 small spines. *Inner uropods* subequal in length to the telson, curiously twisted and bent inwards at the extremity; inner margin as far as the twist just referred to densely packed with very numerous setiform spines, which overlies each other; otolith large.

Hab. Off Balta, Shetland, in 40-50 fath.; Blackhall Rocks, co. Durham, tide-marks; Jersey (*A. M. N.*); Banff (*T. Edward*); Firth of Forth (*T. Scott*): *Mus. Nor.*

Distribution. Professor G. O. Sars once observed this species swimming by the shore at Lister, on the Christiania Fiord, in enormous shoals. North Sea, lat. 56° 50' N., long. 5° 10' E. (*Kinberg*, fide *Goës*); Denmark (*Meinert*); Holland (*P. P. C. Hoek*); Bouchottes, France (*Giard*)*.

2. *Schistomysis ornata* (G. O. Sars).

1864. *Mysis ornata*, G. O. Sars, Beret. om en i Somm. 1863 foretagen Zool. Reise, p. 18.

1869. *Mysis ornata*, Norman, "Last Report Dredging Shetland Isles," Brit. Assoc. Rep. for 1868, p. 266.

1879. *Mysis ornata*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 62, pl. xxix.

1883. *Synmysis ornata*, Czerniavsky, l. c. fasc. iii. p. 56.

1885. *Mysis Kervillei*, G. O. Sars, in de Kerville, "Crust. Schizopodes de l'estuaire de la Seine," Bull. Soc. des Amis des Sci. Nat. de Rouen, p. 92, pl. v.

General form less slender than that of *S. spiritus*; anterior portion of cephalothorax nearly as wide as the earlier segments of pleon; ornamented with red, yellow, or brown branching pigment-spots. *Eyes* short and large, scarcely longer than broad; cornea largely developed. *Antennules* having the peduncle of moderate length and stoutness; flagella long, the

* See Giard (A.), "Le Laboratoire de Wimereux en 1888, Recherches Fauniques" (Bull. Sci. de la France et de la Belgique, 1888, p. 220), for this and other references to him.

outer as long as cephalothorax. *Antennal scale* subrhomboidal, slightly longer than peduncle of antennules, three times as long as broad; external margin short, and this portion of the scale extended beyond the spine which terminates the outer margin; typically almost equal to half of the total length, but sometimes proportionately shorter. *Tarsus* of legs rather longer than preceding joint, consisting of five to seven articulations; nail slender, setiform. *Telson* in form and armature nearly as in *S. spiritus*, but the cleft somewhat deeper and occupying about one fourth of the total length. *Inner uropod* (not twisted at the extremity as in *S. spiritus*) with about sixteen well-separated rather slender spines on the inner margin; otolith large. Length 18 millim.

Hab. Dredged in 40-50 fath. 5-8 miles off Balta, Shetland; off Seaham, on the Durham coast; off Valentia, Ireland (*A. M. N.*); Banff (*T. Edward*); 25 miles off May Island, in the Firth of Forth, 35 fath. (*Dr. John Murray*); Firth of Forth (*T. Scott*): *Mus. Nor.* Liverpool Bay (*A. O. Walker*).

Distribution. Bukken, Bergen Fiord (*A. M. N.*); Dröbak and several places in South and West Norway, and among Lofoten Islands (*G. O. Sars*); Denmark (*Meinert*); Concarneau, France (*Bonnier*); mouth of the Seine (*de Kerville*); Holland (*P. P. O. Hoek*, who records both *S. ornata* and *S. Kervillei*).

Mysis Kervillei is founded on large specimens of *S. ornata* in which the eye is proportionately larger, the antennal scale, more especially the part before the extremity of lateral margin, longer, and the number of articulations in tarsus of legs seven. But among specimens kindly sent me by M. de Kerville I find some with the spine-point of the scale on a level with the end of the peduncle of antenna and the tarsus five-jointed; and in specimens from other localities I find considerable variation both in the scale and tarsus, the latter in the front feet having sometimes seven articulations besides the nail.

3. *Schistomysis Parkeri*, sp. n. (Pl. X. figs. 1-7.)

Mandible having the penultimate and last joints of the palp remarkably broad, the latter more so than in any other member of the genus, scarcely more than twice as long as broad. *Eyes* nearly globular, length scarcely exceeding the breadth. *Antennules* with peduncles short, first joint equalling the two following, second joint transversely narrowly triangular, third joint expanded and very broad, breadth exceeding

length; distally furnished with a circlet of very long plumose setæ, which reach nearly half the length of the very short inner filament, which in the described specimens has only thirteen articulations. *Antennal scale* ovate, broad, with broad, well-rounded extremity; breadth two fifths of length; outer margin naked, terminating in a large spine which is just on a level with the extremity of peduncle of antennæ; extremity reaching far beyond that spine; the second joint bearing six setæ. *Legs* having tarsus composed of four or five articulations. *Telson* cleft at the apex to rather more than one fourth of the length, serrations of cleft unusually few and large (about 40); lateral margin with 15-17 spines. *Inner uropods* remarkably twisted and bent; inner margin with about 15 spines on its central portion, of which the more distal are of great size and equal in length to the breadth of the uropod at that part; beyond this the uropod is very narrow, and just before the extremity there is a single very large spine. *Outer uropods* much longer than inner, unusually parallel-sided; extremity widely truncate, eight setæ taking their origin from this blunt extremity. Length 10 millim.

The male has the sexual lobe of the antennules of great size and linguiform, the extremity arching backwards and inwards; inner filament longer than in female, outer directed at nearly a right angle outwards. *Penis* not twice as long as broad.

Hab. Starcross, Devon (*Mr. C. Parker*, 1884): *Mus. Nor.*

This species is distinguished at once from all others by the character of the uropods, especially the inner. There is a slight tendency to a twist in the same organ in *S. spiritus*, but to nothing like the extent to which it is carried in the present species, while the spination of the inner margin is quite different from that and from all other forms.

4. *Schistomysis Helleri* (G. O. Sars).

1876. *Mysis Helleri*, G. O. Sars, Nye Bidrag til Kundskaben om Middelhavets Littoralfauna, I. Middelhavets Mysider, p. 8, pls. i. and ii.

1883. *Austromysis Helleri*, Czerniavsky, *l. c.* fasc. iii. p. 67.

1885. *Mysis Helleri*, Oarus, *l. c.* p. 266.

General form short and robust; width of cephalothorax in front subequal to that of first segments of pleon; adorned with branching pigment-cells. *Eyes* short, somewhat pyriform; the cornea reaching a little beyond the sides of the cephalothorax. *Antennules* having the peduncles moderately long and moderately robust; the flagella long, the external longer than the cephalothorax. *Antennal scale* rhomboidal,

about three times as long as broad and one third longer than peduncles of antennules, about one third of its length extended beyond the spine which terminates the naked outer margin. *Legs* having the tarsus subequal in length to the preceding joint, composed of four articulations, the first of which is very short and nodulously swollen; nail long and slender; last peræopods very short, about half the length of preceding pairs, and without any nail. *Telson* broad, sides flexuous, but the breadth much more equal throughout the length than usual, scarcely narrowing distally; greatest breadth subequal to half the length; cleft short, scarcely one fifth of length, triangular, widely open; lateral margins of telson with 14-16 spines distributed throughout the length. *Inner uropods* a little longer than telson, with only about nine widely separated spines on the inner margin, the most distal some way from the extremity. *Outer uropods* nearly one third longer than the inner. Length 11 millim.

Hab. Guernsey; Starcross, Devon (*A. M. N.*); Jersey (*Sinel*): *Mus. Nor.*

Distribution. In the Mediterranean at Goletta, Syracuse, and Spezia (*G. O. Sars*).

The nodulous first joint of tarsus of the legs and the few spines on the margin of the inner uropods distinguish *S. Helleri* from the species which have a somewhat similar antennal scale.

5. *Schistomysis arenosa* (*G. O. Sars*).

1876. *Mysis arenosa*, *G. O. Sars*, Nye Bidrag til Kundskaben om Middelhavets Invertebratfauna, I. Middelhavets Mysider, p. 16, pls. v. and vi.

1883. *Austromysis arenosa*, Czerniavsky, *l. c.* fasc. iii. p. 67.

1885. *Mysis arenosa*, Carus, *l. c.* p. 466.

1886. *Mysis arenosa*, Norman, Fourth Annual Report Fishery Board of Scotland, p. 159; and Ann. & Mag. Nat. Hist. ser. 5, vol. xix. 1887, p. 96.

A small species of short and very robust form, much coloured with pigment-cells, especially upon the cephalothorax; pleon shorter than usual. *Eyes* very short, subglobose, scarcely reaching beyond the sides of the cephalothorax; cornea large. *Antennules* with robust peduncle. *Antennal scale* short, subrhomboidal or subovate, scarcely longer than peduncle of antennules; length scarcely exceeding twice the breadth; inner margin more arched than usual, outer margin also slightly arcuate; nearly one half of the total length of scale extended beyond the spine which terminates the naked outer margin. *Legs* with tarsus shorter than preceding

joint, in the anterior pairs composed of four to five articulations, of which the first (as in *S. Helleri*) is very short and nodulously swollen; nail setiform. *Telson* long and not broad, breadth at base scarcely equal to half the length, considerably narrowing to the extremity; cleft of moderate width, extending about one fourth of total length; outer margin with about sixteen spines, the four or five basal spines separated by an interval from the following. *Inner uropods* with numerous spines (20-22) arranged in sets, each set commencing with a small spine, followed by others of gradually increasing length, the most distal spine at (but not on) the extremity—a position most unusual; otolith small. *Fourth pleopods* of male of the structure which usually prevails in this group, but rather shorter than usual. Length 7 millim.

Hab. Starcross, Devon, 1884 (*Mr. C. Parker*); Tarbert, Loch Fyne, 1885 (*Mr. G. Brook*): *Mus. Nor.*

Distribution. The types of the species were taken by Prof. G. O. Sars at Goletta, in the Mediterranean.

Characteristic features of this species are the nodulous character of the first joint of the tarsus of the legs, by which it may be distinguished from all species except *S. Helleri*; and from that species its smaller size, stouter build, and the narrower telson, shorter antennal scale, and armature of uropods distinguish it; moreover in this species the outer uropod is not more than one fifth longer than the inner, but in *S. Helleri* it is at least one third longer.

Genus 12. *MYsis*, Latreille.

Very like in all respects to *Schistomysis*, but *antennal scale* lanceolate (or subulate in *M. mixta*), four and a half to nine times as long as broad, ciliated all round; apex narrowly rounded (or spiniform in *M. mixta*). *Fourth pleopod* of male similar in jointing and general structure to those of *Schistomysis*, and in *M. mixta* in all ways conforming to that genus; but in other species (*M. oculata* and *M. relicta*) the outer branch is much shorter, not more than two or three times the length of inner branch, while the outer flagellum is reduced to a spine-like process and the inner has the first articulation much thickened, so as to almost resemble the joint from which it springs, and the second articulation is reduced to a spine-like process.

M. oculata, Fabr., must be regarded as the type of the genus *Mysis*.

Mysis relicta, Lovén.

1861. *Mysis relicta*, Lovén, Öfversigt af Vet.-Akad. Förhand. p. 285.
 1867. *Mysis oculata*, var. *relicta*, G. O. Sars, Hist. Nat. des Crust. d'eau douce de Norwège, i. p. 14, pls. i.-iii.
 1868. *Mysis relicta*, Kessler, Materialia ad cognos. lacus Onegæ, p. 78, pl. i. figs. 1 a-d.
 1870. *Mysis relicta*, Jarzynsky, Præmissus Catal. Crust. decap. invent. in mari albo &c. p. 317.
 1872. *Mysis diluvianus*, Stimpson, MS., Hoy, Trans. Wisconsin Acad. vol. i. p. 100 (no description).
 1871. *Mysis relicta*, S. I. Smith, Amer. Journ. Sci. and Arts, vol. ii. p. 5.
 1874. *Mysis relicta*, S. I. Smith, Report 1872-3 Commission Fish and Fisheries, p. 648, pl. i. fig. 2.
 1879. *Mysis relicta*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 78, pl. xxxii.
 1882. *Mysis relicta*, Czerniavsky, l. c. fasc. ii. p. 8, fasc. iii. p. 51, pl. xv. figs. 17-20, pl. xvi., and pl. xvii. fig. 1.

Form rather slender; anterior portion of cephalothorax subequal in breadth to earlier segments of pleon; hyaline, with arborescent pigment-cells. *Eyes* large, pyriform; peduncle long; almost the whole of the cornea projected beyond the sides of the cephalothorax. *Antennules* having the peduncle long and moderately stout, basal joint as long as the two following. *Antennal scale* in form as a long ellipse, fully one fourth longer than peduncle of antennules and four times as long as broad; greatest breadth subcentral; ciliated all round, and right down the outer margin to the very base; apical joint bearing four setæ. *Legs* having the tarsus much longer than the preceding joint and composed of six to seven articulations, of which the first is much the longest; nail very slender and setiform. *Telson* gradually tapering, with straight sides; length to greatest breadth as 5 to 2; cleft shallow and very broad and open, about one seventh the length of the telson; sides of telson with about sixteen spines, which are crowded towards the base, but widely separated towards the extremity, and the most distal anterior to the cleft. *Inner uropods* with only four or five spines on the anterior two thirds of the inner margin. *Fourth pleopods* of male having the basal joint of moderate length and the inner branch as usual, but the outer branch remarkably short, not twice the length of the inner. Length 18 millim.

Hab. Lough Neagh, Ireland (A. M. N.).

Distribution. Lakes Vettern, Venern, Malar, and other lakes in Sweden (Lovén & Lilljeborg); Lake Mjösen, Norway (G. O. Sars); Lake Onega, Russia, and Lakes Ladoga and Putko, in Finland (Jarzynsky); northern part of the Gulf of Bothnia, but not observed south of Quarken; Kallavesi,

Maanninga sjö, Päijänne, Pielisjarvi, and other lakes in Finland (*Nordquist*)*.

In America in Lake Michigan (*Stimpson*); Lake Superior, in 12-148 fath. (*S. I. Smith*).

Genus 13. NEOMYSIS, Czerniavsky, 1882.

= *Heteromysis*, Czerniavsky, 1882 (nec Smith).

Antennal scale subulate, very long and narrow, six to ten times as long as broad (running out into an acute spine-like termination), ciliated on both margins. Labrum acutely pointed in front. *Legs* with multiarticulate tarsus; posterior pairs more strongly built than the anterior and with more articulations in tarsus. *Telson* subtriangular, elongated; apex entire, pointed; margins spined, the spines subequal, no smaller spines alternating with larger. In the male the third as well as the first, second, and fifth *pleopods* are simple, and resemble the same organs in female: fourth pleopod with a short peduncle, not much longer than broad: inner branch as usual in *Mysinae*; outer branch consisting of only two articulations, the first very long, the second rather short, from its end spring two subequal, spiniform, ciliated filaments of no great length.

Mysis awatschensis, F. Brandt, *M. americana*, Smith, *Heteromysis mirabilis*, Czern., and *H. intermedia*, Czern., are referable to this genus.

Neomysis vulgaris (J. V. Thompson).

(Pl. X. figs. 12, 13.)

1828. *Mysis vulgaris*, J. V. Thompson, Zoolog. Researches, i. p. 30, pl. ii.

1844. *Mysis vulgaris*, Zaddach, Synops. Crust. prussicorum prod. p. 3.

1853. *Mysis vulgaris*, Bell, Brit. Stalk-eyed Crust. p. 339.

1860. *Mysis vulgaris*, P. J. Van Beneden, Recher. sur la Faune littorale de Belgique, Crustacés, p. 13, pl. i.

1861. *Mysis vulgaris*, Kröyer, Nat. Tidssk. 3die Række, vol. i. p. 21.

1879. *Mysis vulgaris*, G. O. Sars, Carcinol. Bidrag til Norges Fauna, I. Monogr. Mysider, p. 24, pl. i.

1882. *Neomysis vulgaris*, Czerniavsky, l. c. fasc. ii. p. 23, fasc. iii. p. 81, pl. xviii. figs. 18-22, pl. xxx. figs. 12-14.

Antennal scale of great length and very narrow, lanceolate, nine or ten times as long as greatest breadth and three

* Nordquist (Osc.), "Bidrag till känn. om Crustacéfauna, I. Nagra af Mellersta Finlands Sjöar, 1886," Act. Soc. pro Fauna et Flora Fennica, iii. n 2; and "Bid. till känn. om Bottniska vikens och norra Osterjons evertebratfauna," Soc. pro Fauna et Flora Fennica, 17 (1860).

times as long as peduncle of antennules, ciliated all round right down to the base of outer margin; a long very narrow second joint, which is furnished with two setæ on each side and terminates in an acute spine-like point. *Legs* having tarsus longer than the preceding joint, of six articulations in the earlier pairs and of eight in the last; nail slender. *Telson* rather more than twice as long as the breadth at the base, in the form of an elongated triangle, gradually attenuating, but with flexuous side to the extremity, which is very narrow, abruptly truncated, and entire, bearing four spines, the outer pair of large size and the pair between them of about half their length; sides of telson with 20-25 spines, most crowded towards the base and becoming more widely separated distally. *Inner uropods* having a group of densely packed spinules situated on the inner margin just below the large otolith; these spines occupy about one fourth of the total length of the margin. *Third pleopods* of male similar to those of female.

Hab. Found all round our coast in brackish water at mouths of rivers, estuaries, salt-marshes, and such like places; but it seems to require more saline ingredients in the water than does *Palæmonetes varians*, Leach, which latter species is often found living in water in which no trace of salt is perceptible and which is occupied by an otherwise freshwater fauna and flora.

Mr. A. O. Walker tells me that about one out of every three specimens received by him from the little river Alt, which is a short way north of the Mersey, was more or less abnormal in the spination of, and in some cases in the form of, the telson. He adds that "a good deal of sewage runs down the river," which may account for the irregular development. These specimens had in some cases the two terminal small spines replaced by spines of similar size to the outer pair. This gave a totally different appearance to the end of the telson, which now appeared narrowly rounded and beset with equal-sized spines. I figure the abnormal terminations of the telson in the case of two specimens which Mr. Walker kindly gave me (Pl. X. figs. 12, 13).

Distribution. Norwegian coast, from Christiania to Trondhjem (*G. O. Sars*); Baltic (*Lindström*); Sweden (*Lilljeborg*); Finland (*Cajander*); Denmark (*Krøyer*); Holland (*P. P. C. Hoek*); Belgium (*Van Beneden*); Boulogne, France (*Giard*); Havre; Concarneau (*J. Bonnier*); mouth of the Seine (*de Kerville*); [Black Sea (*Grebritzky*)?]; White and Murman Seas (*Jarzynsky*)*.

* In Wagner (N.), 'Die Wirbellosen des weissen Meeres,' 1885, p. 170.

CORRIGENDA.

- (1) In the first part of this paper, in the Table of Distribution, p. 145, for "*Synmysis*" read "*Macromysis*."
 (2) At p. 141 and pp. 149-152 *passim*, for "*Cynthilia*" read "*Siriella*."
 (3) At pp. 147 and 149, for "Subfam. *Cynthiliinæ*" read "Subfam. *Siriellinæ*."

These corrections are necessary from the fact that I find that the genus *Siriella* does not date from 1852, as had been supposed, but was first instituted by Dana in his preliminary descriptions in 'American Journal Sci. and Arts,' ser. 2, vol. ix. p. 4, and that this paper appears to have been published in the early part of 1850; whereas the Brit. Mus. Cat. Brit. Crustacea, which bears J. E. Gray's name, but was "prepared by Mr. Adam White," is signed "June 15, 1850," and must have been published subsequently to that date.

EXPLANATION OF THE PLATES.

PLATE IX.

- | | | |
|----------|---|--|
| Fig. 1. | <i>Mysidopsis hibernica</i> , Norman. | Antenna and its scale. |
| Fig. 2. | " " " | Inner uropod. |
| Fig. 3. | " " " | Telson. |
| Fig. 4. | " " " | Extremity of telson, more magnified. |
| Fig. 5. | " " " | Terminal joints of outer branch of fourth pleopod of the male. |
| Fig. 6. | <i>Heteromysis formosa</i> , S. I. Smith. | Antennule and eye. |
| Fig. 7. | " " " | Antenna and scale. |
| Fig. 8. | " " " | Terminal joints of a posterior leg. |
| Fig. 9. | " " " | First leg. |
| Fig. 10. | " " " | Uropod. |
| Fig. 11. | " " " | Telson. |

PLATE X.

- | | | |
|---------------|--|---|
| Fig. 1. | <i>Schistomysis Parkeri</i> , Norman. | Antennule, ♂. |
| Fig. 2. | " " " | Antennule, ♀. |
| Fig. 3. | " " " | Antenna and scale. |
| Fig. 4. | " " " | Uropods. |
| Fig. 5. | " " " | Telson. |
| Fig. 6. | " " " | Fourth pleopod, ♂. |
| Fig. 7. | " " " | Endopodite of a leg. |
| Fig. 8. | <i>Mysidopsis gibbosa</i> , G. O. Sars. | End of telson. |
| Fig. 9. | " <i>angusta</i> , G. O. Sars. | End of telson. |
| Fig. 10. | <i>Erythrops elegans</i> , G. O. Sars. | Telson. |
| Fig. 11. | " <i>serrata</i> , G. O. Sars. | Antennal scale. |
| Figs. 12, 13. | <i>Neomysis vulgaris</i> , J. V. Thompson. | Abnormal developments of the end of the telson. |

The figures in the foregoing Plates are of parts magnified to various degrees of enlargement.

XXX.—*Note on the Steatomys of Angola.*
By OLDFIELD THOMAS.

By the kindness of Prof. Barboza du Bocage the British Museum has received a large number of the small mammals on which his recent papers on the Mammals of Angola were based, and amongst them are a pair of the animal referred by him* to *Steatomys edulis*, or, as it ought to be called, *S. pratensis* †, Peters. In so referring it, however, he remarks on the great difference in size which exists between the Angolan and Mozambique forms—a difference which, on direct comparison of specimens from both localities, I am disposed to consider as of fully specific value. This being the case, the Angolan form will need a new specific name, and I cannot apply to it a better one than that of Prof. Bocage himself, whose invaluable papers on the mammals of that country form an epoch in the advancement of our knowledge of African mammalogy.

Steatomys Bocagei, sp. n.

Much larger than *S. pratensis* and with a longer tail, but with proportionally rather shorter ears. Skull apparently quite similar in form to that of the Zambesi animal, except that the bullæ seem to be rather broader and more flattened and the infraorbital foramina more widely open. The decided difference in size is best shown by the comparative skull-measurements given below.

Dimensions of an adult female in spirit:—

Head and body 97 millim.; tail 57; hind foot 18·2; ear (above crown) 11·4.

Skull-dimensions of the above female and of a fully adult specimen of the same sex from Mozambique, collected and determined by Prof. Peters, and which may therefore be looked upon as a co-type of *S. pratensis*:—

| | <i>S. Bocagei.</i> | <i>S. pratensis.</i> |
|----------------------------|--------------------|----------------------|
| Basal length | 23·9 | 20·1 |
| Greatest breadth | 13·9 | 12·0 |
| Nasals, length | 11·0 | 9·5 |
| Interorbital breadth | 4·0 | 3·8 |

* J. Sci. Lisb. (2) v. p. 17 (1890).

† MB. Ak. Berl. 1846, p. 258. In his larger work (Saug. Mossamb. p. 163, 1852) Peters altered the name into *S. edulis*, but the alteration is, of course, quite invalid. The same remark applies to *Saccostomus lupidarius*, Pet. (1852), which ought to stand as *S. campestris*, Pet. (1846).

| | <i>S. Bocagei.</i> | <i>S. pratensis.</i> |
|-----------------------------------|--------------------|----------------------|
| Interparietal, length | 3·2 | 2·4 |
| " breadth | 9·4 | 9·0 |
| Palate, length | 14·2 | 12·1 |
| Diastema | 7·3 | 6·3 |
| Length of palatine foramina ... | 5·7 | 4·8 |
| Length of upper molar series | 4·4 | 3·8 |

The specimen here described and measured was obtained at Caconda by M. Anchieta.

The second species described by Peters, *S. Krebsi**, from Caffraria, shows no approximation to *S. Bocagei* and is very doubtfully separable from *S. pratensis*.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

June 22nd, 1892.—W. H. Hudleston, Esq., M.A., F.R.S.,
President, in the Chair.

The following communication was read :—

“Contribution to a Knowledge of the Saurischia of Europe and Africa.” By Prof. H. G. Seeley, F.R.S., F.G.S.

The Saurischia are defined as terrestrial unguiculate Ornithomorpha, with pubic bones directed downward, inward, and forward to meet in a ventral union. The forms of the pelvic bones vary with the length of the limbs, the acetabulum becoming perforate, the ilium more extended, the pubis and ischium more slender, and the sacrum narrower as the limb-bones elongate. The order is regarded as including the Cetiosauria, Megalosauria, and Aristosuchia or Compsognatha.

The Cetiosaurian pelvis has been figured in the Quart. Journ. Geol. Soc.; and a restoration is now given of the pelvis in *Megalosaurus*, *Streptospondylus*, and *Compsognathus*.

The characters of the skull are evidenced by description of the hinder part of the skull in *Megalosaurus* found at Kirtlington, and preserved in the Oxford University Museum. In form and proportions it closely resembles *Ceratosaurus*, and the corresponding region of the head in Jurassic Ornithosauria. The brain-cavity and cranial nerves are described, and contrasted with those of *Ceratosaurus*.

The skull in Cetiosauria, known from the American type *Diplodocus*, is identified in the European genus *Belodon*, which is regarded as a primitive Cetiosaurian.

Part 2 discusses the pelvis of *Belodon*, restored from specimens in the British Museum, and regarded as Cetiosaurian. A restoration of the shoulder-girdle is made, and found to resemble that in Ichthyosaurs, Anomodonts, and Dinosauria. The vertebræ in form and

* Saug Mossamb. p 165 (1852).

articulation of the ribs are Saurischian, the capitular and tubercular facets being vertical in the dorsal region, and not horizontal as in Crocodiles. The humerus shows some characters in common with that of *Stereorachis dominans*, in the epicondylar groove. In general character the limb-bones are more Crocodilian than the axial skeleton. The interclavicle is described, and regarded as a family characteristic of the Belodontidæ.

In the 3rd part an account is given of *Staganolepis*, which is regarded as showing a similar relation with the Megalosauria, to that of *Belodon* with the Cetiosauria. This interpretation is based chiefly upon the identification of the pubic bone in *Staganolepis*, which has the proximal end notched as in *Zanclodon* and *Streptospondylus*; and the inner ridge at the proximal end is developed into an internal plate. A note follows on the pelvis of *Aetosaurus*, which is also referred to the Saurischia on evidence of its pelvic characters, approximating to the Cetiosaurian sub-order.

Part 4 treats of *Zanclodon*, which is regarded as closely allied to *Massospondylus*, *Euskelesaurus*, and *Streptospondylus*. It is founded chiefly on specimens in the Royal Museum at Stuttgart, and in the University Museum at Tübingen. The latter are regarded as possibly referable to *Teratosaurus*, but are mentioned as *Zanclodon Quenstedti*. The pelvis is described and restored. *Zanclodon* has the cervical vertebræ relatively long, as compared with *Megalosaurus*, and small as compared with the dorsal vertebræ, which have the same Teleosauroid mode of union with the neural arch as is seen in *Streptospondylus* and *Massospondylus*. The sternum, of Pleininger, is the right and left pubic bones; but there is much the same difference in the proximal articular ends of those bones in the fossils at Stuttgart and Tübingen, as distinguishes corresponding parts of the pubes in *Megalosaurus* and *Streptospondylus*. The ilium is more like that of *Palæosaurus* and *Dimodosaurus*. The limb-bones and digits are most like those of *Dimodosaurus*, but the teeth resemble *Palæosaurus*, *Euskelesaurus*, *Megalosaurus*, and *Streptospondylus*.

Part 5 discusses *Thecodontosaurus* and *Palæosaurus* upon evidence from the Dolomitic Conglomerate in the Bristol Museum. An attempt is made to separate the remains into those referable to *Thecodontosaurus* and those belonging to *Palæosaurus*. The latter is represented by dorsal and caudal vertebræ, a scapular arch, humerus, ulna (?), metacarpals, ilium, femur, tibia, fibula, metatarsals, and phalanges. These portions of the skeleton are described. There is throughout a strong resemblance to *Zanclodon* and other Triassic types. A new type of ilium, and the humerus originally figured are referred to *Thecodontosaurus*.

Part 6 gives an account of the South African genus *Massospondylus*. It is based partly upon the collection from Beauchert, in the Museum of the Royal College of Surgeons, referred to *M. carinatus*; and partly upon a collection from the Telle River, obtained by Mr. Alfred Brown of Aliwal North, referred to *M. Browni*. The former is represented by cervical, dorsal, sacral, and caudal vertebræ;

ilium, ischium, and pubis; femur, tibia; humerus, metatarsals, and phalanges. The latter is known from cervical, dorsal, and caudal vertebræ, femur, metatarsals, and bones of the digits. The affinities with *Zanclodon* are, in some parts of the skeleton, stronger than with *Euskelesaurus*.

Part 7 gives an account of *Euskelesaurus Browni*, partly based upon materials obtained by Mr. Alfred Brown from Barnards Spruit, Aliwal North, and partly on specimens collected by the Author, with Dr. W. G. Atherstone, Mr. T. Bain, and Mr. Alfred Brown, at the Kraai River. The former series comprises the maxillary bone and teeth, vertebræ, pubis, femur, tibia and fibula, phalanges, chevron bone and rib. The latter includes a cervical vertebra and rib, and the lower jaw. The teeth are stronger than those of *Teratosaurus*, or any known Megalosaurian. The anterior part of the head was compressed from side to side, and the head in size and form like *Megalosaurus*, so far as preserved. The pubis is twisted as in *Staganolepis* and *Massospondylus*, with a notch instead of a foramen at the proximal end, as in those genera; and it expands distally after the pattern of *Zanclodon*. The chevron bones are exceptionally long, and the tail appears to have been greatly elongated. The femur is intermediate between *Megalosaurus* and *Palæosaurus*, but most resembles *Zanclodon* and *Massospondylus*. The tibia in its proximal end resembles many Triassic genera; and in its distal end is well distinguished from *Massospondylus* by its mode of union with the astragalus. The claw-phalanges are convexly rounded, being wider than is usual in Megalosauroids. The lower jaw from the Kraai River gives the characters of the articular bone, and the articulation, as well as of the dentary region and teeth. The cervical vertebra is imperfect, but is remarkable for the shortness of the centrum, being shorter than in *Megalosaurus*.

In Part 8 an account is given of *Hortalotarsus skriptodus* from Barkly East, preserved in the Albany Museum. It is an *Euskelesaurian*, and exhibits the tibia and fibula, and tarsus. There is a separate ossification for the intermedium, which does not form an ascending process; and the astragalus is distinct from the calcaneum. The metatarsals are elongated, and the phalanges somewhat similar to those of *Dimodosaurus*.

Part 9, in conclusion, briefly examines the relations of the Saurischian types with each other, and indicates ways in which they approximate towards the Ornithosauria. It is urged that the Ornithosauria are as closely related to the Saurischia as are the Aves to the Ornithischia; and that both divisions of the Saurischia approximate in *Staganolepis* and *Belodon*. Finally, a tabular statement is given of the distribution in space and time of the 25 Old-World genera which are regarded as probably well established. Eight of these are referred to the Cetiosauria, thirteen to the Megalosauria, and four to the Aristosuchia or Compsognatha.

MISCELLANEOUS.

Note on Dr. Hinde's Tertiary Sponge-spicules.

By R. v. LENDENFELD.

DR. HINDE ("On the Spongo-remains in the Lower Tertiary Strata near Oamaru, Otago, New Zealand," Journ. Linn. Soc., Zool. vol. xxiv.) has described and figured a number of sponge-spicules from the Oamaru beds.

In studying Hinde's figures of tetraxon and polyaxon spicules I have come across several forms exceedingly similar to spicules observed by me in recent sponges different from those mentioned by Hinde as their nearest recent allies. These are the following:—

Protirien (pl. xiii. figs. 16, 17, p. 234), referred by Hinde to *Craniella cranium*, is identical with the protirien of *Stelletta hispida* (Buccich).

Dichotriën with short rhabdom (pl. xiii. figs. 7, 8, 11, 12, p. 234), referred by Hinde partly to *Stelletta* and *Geodites*, is in every way similar to the dichotriën of *Erylus discophorus* (O. Schmidt).

Dichotriën with long rhabdom (pl. xiii. figs. 3, 4, 5, p. 233), referred by Hinde to *Geodites*, is similar to the dichotriën of *Ano-rina cerebrum* (O. Schmidt).

Anatricsen (pl. xiii. figs. 19–24, p. 235) is identical with the anatricsen of *Geodia cydonium* (R. v. L. in sched.) [i. e. *Geodia gigas*, O. Schmidt; *Cydonium Mülleri*, Fleming; *Geodia zellundica*, Johnston, &c.].

Aster (pl. xiv. fig. 18, p. 239), compared by Hinde to that of *Geodia tuberculosa* (Bowerb.), is doubtless a spicule from the ectochrote of a species of *Stelletta*.

Aster (pl. xiv. figs. 28, 29, 30, p. 237), compared by Hinde to that of *Stelletta intermedia* (O. Schmidt), is identical with an aster occurring in the lower portion of the cortex of the *Geodia cydonium* (R. v. L.) above mentioned.

A Contribution to the Knowledge of the Male Sexual Organs of the Diptera. By N. СНОЛОДКОВСКИЙ, St. Petersburg.

Our knowledge of the anatomy of the male sexual organs of the Diptera is tolerably scanty. While the coarser structure of the parts in question has been studied by L. Dufour and Loew, and we have isolated notes thereon by other investigators also*, their finer constitution has hitherto been entirely neglected. In order to supply

* L. Dufour, "Anatomie générale des Diptères," Ann. Sc. Nat. 3 sér. t. i., 1844; L. Dufour, "Recherches anatom. et physiol. sur les Diptères," Mém. présentés à l'Acad. Sci. Paris, t. xi., 1851; H. Loew, "Horne anatomiae.—Entomotomien," Heft i.–iii., Posen, 1841; H. Loew, "Beitr. zur Kennt. d. inneren Geschlechtstheile d. zweifl. Insecten," Germar's 'Zeitschrift f. Entomologie,' iii., 1841; Suckow, "Die Geschlechtsorg. d. Insecten," Hens. Zeitschr. f. organ. Physik, 2 Bd., 1828; Meigen, 'Systemat. Besch. der bekannten europ. zweifl. Insecten,' 1818–38, tab. 34, 35, 43; Hegetschweiler, 'De insectorum genitalibus,' Turici, 1820; Swammerdam, 'Bibel der Natur,' 1752, tab. 42, 43; Burmeister, 'Handbuch d. Entomologie,' 1833, i. Bd., pp. 215–236.

this deficiency I investigated last summer by means of sections the male sexual organs of certain Diptera, especially the genus *Laphria*.

As we are already aware, the internal male genital apparatus of *Laphria* (as of the Asilidæ in general) consists of two long spirally coiled testicular tubes, two vasa deferentia, two long tubular accessory glands, and a short ductus ejaculatorius. The testes are loosely surrounded by a common envelope, which is of a dark red colour and is well supplied with tracheæ. Beneath the envelope lies a fine layer of fat-granules. In structure this layer corresponds to the membrane with which each follicle of the testis of the butterfly is separately clothed, and, like it, it is in all probability formed by the concrescence of the hypodermal layer of the tracheæ*.

The wall of the testicular tube consists of a thin but firm nucleated membrane, beneath which there further lies a structureless membrana propria. Parietal epithelium is not found in the testis, except at the spot where it passes into the vas deferens, where the epithelium appears at first flattish, and then continually more and more columnar. The vasa deferentia as well as the accessory glands possess an external membrane similar to that of the testis, while the ductus ejaculatorius is surrounded by a thick multilaminar membrane, which is very feebly stainable with carmine and contains numerous nuclei. This membrane also envelops the vasa deferentia and the accessory glands at their transition into the ductus ejaculatorius, in consequence of which the four tubes when examined under a low power appear to be united for a space into a common cord. The epithelium of the vasa deferentia is cylindrical, but not columnar; in the accessory glands the cells of the epithelium are very columnar in places, and form a number of longitudinal ridges, projecting considerably into the lumen of the gland, between which the epithelium is flat. The ductus ejaculatorius is clothed with columnar cylindrical epithelium, the cells of which contain large vacuoles in their peripheral extremities, and secrete a thick chitinous intima.

The tracheæ, which surround the testis in abundance, do not penetrate into its cavity, just as is also the case in other insects. In this respect I most decisively maintain my statements as to the structure of the testis of the butterfly, in opposition to the objections of Tichomirow and Koschewnikoff†. In his paper on the sexual apparatus of the humble-bee ("Drohne") Herr Koschewnikoff indeed confirms my view, by alluding to the fact that in *Apis* the tracheæ do not penetrate into the cavities of the separate testicular tubules. Further on, however, he writes:—"If we consider the structure of the envelopes, the entire testis of the humble-bee is

* N. Cholodkovsky, 'Der männliche Geschlechtsapparat der Lepidopteren,' St. Petersburg, 1886 (in Russian).

† Tichomirow, 'Entwicklungsgeschichte von *Bombus mori*,' Moskau, 1882 (in Russian); Koschewnikoff, 'Ueber den Bau des Geschlechtsapparates der Drohne,' Moskau, 1891 (in Russian); Koschewnikoff, "Zur Anatomie der männlichen Geschlechtsorgane der Honigbiene," Zool. Anzeiger, 1891, no. 376, pp. 303-306 (Ann. & Mag. Nat. Hist. ser. 6, vol. ix., Feb. 1892, pp. 185-187).

comparable rather to a section ('scompartemento,' Verson; 'Samenfollikel,' Cholodkovsky) of the compound testis of the Lepidoptera." But since the cavity of the genital glands is undoubtedly homologous in different insects, the distinction proposed by Koschewnikoff has no justification whatever. In the form in which he would refute my view in his paper in the 'Zoologischer Anzeiger' (no. 376; Ann. & Mag. Nat. Hist., Feb. 1892:—"The belief that in butterflies there are no tracheæ within the testis is erroneous"), Koschewnikoff's reply is even devoid of all actual foundation, for I never said that there are no tracheæ within the testis: I merely maintained, as I do still, that into the *cavity of the testis*, where balls and bundles of spermatozoa lie, the tracheæ do not penetrate.

The spermatogeny of *Laphria* is of a very peculiar kind, which vividly reminds us of the process described by Verson for *Bombyx mori**. In the blind club-like swollen end of the testicular tube lies a colossal cell, visible with the naked eye; this is the spermatogonia, from which the entire contents of the testis are derived. In *Bombyx* this spermatogonia is found in the larval stage, but in *Laphria* it remains active in the imago and exists simultaneously with numerous completely developed bundles of spermatozoa, which distend the middle and lower sections of the testicular tube. From this cell proceed ray-like outgrowths of plasma (as in the case of *Bombyx mori*), in which numerous nuclei are imbedded. I have never found a single large nucleus (Verson) in the central mass of the plasma of the spermatogonia, but always *several large nuclei* of irregular and very varied form, which took either a slight or a very deep stain from carmine. In addition to this I always found in the central plasma-mass of the spermatogonia numerous small chromatin corpuscles, which sometimes appeared somewhat curved and were frequently united into little heaps. Judging by these figures the division of the nucleus in the spermatogonia of *Laphria* is not amitotic (as described by Verson for *Bombyx mori*), but is effected by typical mitosis.

As regards the other groups of Diptera, my knowledge of the finer structure of the sexual apparatus is at present still incomplete. I therefore here venture to say only a few words as to the testes of the genus *Calliphora*. In these flies the two testes are each enclosed in an orange-yellow capsule, and in addition to this are surrounded by a special saccule of the fat-body. Within this saccule, that is between its wall and the testicular capsule, lie peculiar cells of very large size, whose plasma contains numerous large globules, which are apparently hard and take a very deep stain from fuchsin. The significance of these remarkable cells appears at present quite enigmatical.—*Zoologischer Anzeiger*, xv. Jahrg., no. 391, May 16, 1892, pp. 178-180.

* E. Verson, 'La spermatogenesi nel *Bombyx mori*,' Padova, 1880; Verson, "Zur Spermatogenesis," *Zool. Anzeiger*, 1880.

A Contribution to the Embryogeny of the Chalcididæ.

By M. L.-F. HENNEBURY.

The few observations which have been made upon the development of the entomophagous Hymenoptera have shown that the embryogeny of those species which have been studied hitherto is characterized by the absence of nutritive vitellus in the ovum, by the existence of a single embryonic envelope differing from the amnion of the other Insecta, and by the constitution of the larva. As I have had the opportunity of encountering in some larvæ of *Stratiomys strigosa* several stages in the development of a Chalcid parasite, *Smicra clavipes*, with which Swammerdam was already acquainted, I think it will be useful, in spite of the numerous gaps which my investigation exhibits, to mention the facts which I have observed.

In a *Stratiomys*-larva attacked by *Smicra* we find some fifty ova at different stages of development. The youngest which I have examined measured $150\ \mu$ in length by $50\ \mu$ in breadth. These ova have the form of an elongated ovoid, terminated at each extremity by an appendix like the finger of a glove. The chorion of the ovum is very delicate and perfectly homogeneous; its inner surface is clothed by a cellular membrane, formed of a single layer of little flattened cells. Inside this membrane a clear space, filled with fluid, surrounds a solid elongated cellular mass, which results from the total segmentation of the formative vitellus. The cellular membrane probably owes its origin to a very precocious differentiation of the periphery of the segmented vitellus, and constitutes an embryonic membrane which is comparable to that of the Scorpions and of *Polyxenus*.

The ovum, in consequence of progressive development, increases in volume; its chorion becomes distended; the appendices shaped like the finger of a glove disappear almost entirely, and are only represented by two little points which are scarcely visible. At the same time the embryonic membrane increases in area, but without the multiplication of its cells. The latter become enlarged by flattening themselves out more and more; they attain very great dimensions, and each possess a nucleus of considerable bulk.

During the growth of the ovum the central cellular mass becomes hollowed out and differentiates by delamination into two layers, one of which is ectodermic, the other endodermic. The nervous system is formed on the ventral face by two ectodermic thickenings, situated on each side of the median line. At the same time between the two primitive layers of the blastoderm mesodermic elements appear, the origin of which I have not been able to determine. The segments of the body become visible; the cephalic portion is slightly larger than the rest of the body, and exhibits in front a little papilla, on which the mouth-parts will subsequently appear.

At this point the ovum is about $600\ \mu$ in length by $420\ \mu$ in breadth; it has become about two hundred times larger than it was at first. The embryonic membrane, which is separated from the

chorion and from the embryo by a thick layer of albuminous fluid, is still intact, when the little vermiform larva, destitute of any kind of appendages except rudimentary mouth-parts, is already well formed and begins to exhibit movements. At this moment the large flattened cells of the embryonic membrane separate from one another, become free, and assume a globular form; they undergo a fatty degeneration and float freely, isolated or in little groups, in the liquid which surrounds the embryo.

When the larva of *Smicra* emerges it presents almost the same constitution as that of *Encyrtus fuscicollis*, recently described by Bugnion*; it differs from it, however, in its nervous system, which is formed by a double chain in which the ganglia are sharply distinct and which is in connexion with well-developed supra-oesophageal centres. It terminates posteriorly in an acuminate extremity, in front of which opens the anus. The hind-gut, which is very short, does not appear to be in communication with the mid-gut, which is filled with a yellowish liquid without any traces of formed elements.

A large number of embryos of *Smicra* die before arriving at the limit of their development and undergo a fatty degeneration in the interior of the ovum; in addition to this the ova are frequently attacked by the mycelium of a fungus, which perforates the chorion and develops in the albuminous liquid. The presence of this fungus does not appear to injure the larva of the *Stratiomys*, the tissues of which remain perfectly healthy. I have never found more than two or three well-developed larvæ of *Smicra* in the same *Stratiomys*-larva.

The stages which I have so far observed enable me to establish the following facts:—

In *Smicra* the segmentation of the ovum is total; a single embryonic membrane appears at an early period, before the formation of the embryo, by a process very different from that which gives origin to the amnion of other insects. The ovum undergoes a considerable increase in bulk during its development, owing to the remarkable elasticity of its chorion. The embryonic membrane follows the growth of the embryo; the cells attain large dimensions and do not multiply. When the embryo is well formed the cells of the embryonic membrane separate and enter upon fatty degeneration. The ovum borrows from the blood of its host by endosmosis the nutritive materials necessary for its development. Even for a long time after emerging the larva appears to nourish itself only at the expense of the blood of its host.—*Comptes Rendus*, tome cxiv. no. 3 (January 18, 1892), pp. 133–136.

* 'Recueil zoologique suisse,' t. v. (1890).

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SIXTH SERIES.]

No. 58. OCTOBER 1892.

XXXI.—*Notes on the Cuvierian Organs of Holothuria nigra.*
By E. A. MINCHIN, B.A., Assistant in the Department of
Comparative Anatomy, Oxford.

[Plate XVII.]

THE observations here recorded were made by me in the summer of 1890, when I had the honour to occupy one of the British Association tables in the Marine Biological Laboratory at Plymouth, during the months of July, August, and September. For the greater part of the time I was engaged in studying the Gregarines of various marine animals, but especially of *Holothuria nigra*. Of these I obtained an abundance of living specimens, and so was able to observe the Cuvierian organs in the fresh and living condition. It was my intention at the time to work out fully the structure and function of these remarkable organs; but as it has been impossible for me, owing to other work, to carry out my purpose, it seemed best to publish at once the few scattered observations I was able to make.

1. *Anatomical Relations*.—The account of these organs given by Bell (1) is inaccurate in certain details, which is not to be wondered at, since he was only able to examine spirit-specimens. He states (p. 375) that the organs arise from the cloaca and that they differ from any yet described by the fact that they are closely united together into a firm bundle. Both these statements are erroneous and are due to

the fact that when the organs are placed in spirit they become at first exceedingly sticky, and adhere to one another and to everything they touch; so that in spirit-specimens perfectly misleading appearances are obtained.

If a *Holothuria nigra* be opened fresh in sea-water, it is easily seen that the Cuvierian cæca are each quite separate from one another and arise independently from the left respiratory tree (Pl. XVII. fig. 9, *c.o.* and *l.resp.*). In the normal condition they are cylindrical, tapering to a point at their distal extremity. For the most part they are of a pure white colour, but a few are pinkish in tint. The latter are probably freshly formed as outgrowths from the respiratory tree. A healthy animal always contains an enormous number of tubes, and they take up a very large space in the body.

2. *Phenomena of Elongation.*—The most curious property of these organs is their power of elongating to a relatively enormous extent. I will first describe what is seen in the living animal.

If a healthy *Holothuria nigra* be pricked with a needle it first draws in its tentacles and ceases to move. If the stimulation be continued it slowly curls the posterior part of the body up towards the part affected. In a few moments a number of white threads are seen to emerge from the anus and to run about swiftly in all directions. At the end of each thread is a thicker portion or head (*h*, figs. 1 *a* and *b*), which is easily seen to be the cause of the movement; for the thread itself is formed continuously from it at the point *x*, and the head gets smaller and smaller during the process. When first ejected the head averages about 2 centimetres in length. Since the head produces perhaps twenty times its own length of thread or more, it rushes through the water by its own activity. One might compare the head to a rocket and the thread to the trail of sparks emitted by it. Moreover, as the head is generally slightly curved, it runs in any direction. The result is that the irritating body gets enveloped in a network of delicate but exceedingly tenacious and sticky threads. As is well known to the Plymouth fishermen, even animals as large as lobsters become so firmly entangled that they are unable to move. Meanwhile the Holothurian, if the irritation has ceased, walks quietly away, and the Cuvierian threads, as we may call them, being now firmly fixed to some foreign body, break off at their attachment to the respiratory tree. As a rule only a small portion of the tubes contained in the body are emitted at a time, and a healthy Holothurian can emit them five or six times in succes-

sion. The only object which they do not appear to adhere to is the slimy body of the Holothurian itself.

With regard to the cause of this elongation, all the statements known to me in the literature of the subject attribute it to one of two causes, or to a combination of them—(1) to liquid being forced into the tube, (2) to an unwinding of the spirally wound connective tissue in the walls of the tube. Semper (7, p. 139) examined *Bohadschia marmorata*, in which ejection of the Cuvierian organs was not observed, but in which they showed power of elongation. A freshly caught animal was quickly cut open, so that the viscera came out of the wound, without the intestine breaking away from the cloaca. When the cloaca was stimulated at the point where the lowest Cuvierian organs were fixed they all shortened themselves by about a half. In the same way they elongated voluntarily, and became then very long and at the same time thicker. Hence the author concluded that they must possess a contractility of their own and that elongation could only be brought about by an influx of blood. No blood-vessels, however, were observed, and it is quite certain that none exist.

Hérourard (3) attributes their elongation entirely to water being forced in from the cloaca. Having studied *Holothuria catanensis*, he describes them as hollow tubes attached to a dilatation of the respiratory tree and provided with sphincters at their orifices. When the water which is contained in the dilatation of the respiratory tree is compressed by the contraction of its walls it penetrates into the tubes. This can be shown by ligaturing the anus and cutting the body-wall, so as to expose the Cuvierian organs. Certain of the tubes can then be seen to dilate gradually from the base upwards, until equilibrium of pressure is restored. When set free into the surrounding water they dilate by a process analogous to that described above.

Jourdan (4, pp. 49, 50), on the other hand, attributes the whole process (in *H. impatiens*) to the stretching and unrolling of the bundles of connective tissue, commencing at the basilar region. The muscular layers seem to break up and let the connective tissue loose. The tubes are only sticky when ejected. Cuénot (2) steers a middle course, and attributes their elongation within the body (also of *H. impatiens*) and ejection to pressure of liquid from the cloaca, with Hérourard; but after they are ejected the spirally wound muscles and connective tissue unroll, so that the tube elongates, and at the same time the external epithelium changes

into a sticky matter. Bell (1, p. 565), like Jourdan, attributes the elongation of the organs in our form to the unrolling of a spiral thread of connective tissue.

However well this explanation of the elongation as due to the pressure of liquid may apply to Semper's *Bohadschia*, and possibly also to *H. catanensis*, it is totally inapplicable to *H. nigra*, and I believe also to *H. impatiens*. This is shown by the fact that in *H. nigra* an isolated Cuvierian organ can be made to elongate by itself. If in a living animal one of the Cuvierian organs be pricked or otherwise stimulated it will, as Jourdan (4, p. 43) has already observed, go off of itself and elongate in the same manner as those normally thrown out by the animal. My experience in trying to preserve these organs for histology shows this still plainer. Wishing to preserve material for a study of the minute structure of these organs, I carefully removed from freshly opened animals the portion of the respiratory tree to which they were attached and transferred the organs so removed to various preserving liquids. In the process of removal great care was necessary, as the organs, if shaken or pricked, were liable to go off. But I found that in very few preserving fluids was it possible to preserve the organs in their normal form. For instance, the instant they were placed in a saturated solution of corrosive sublimate every single organ commenced at once to elongate rapidly, and it was some seconds before the killing action of the fluid overcame the tendency to elongate. The same result came about whether the solution was warm or cold, and also in Kleinenberg's picric, in corrosive and acetic mixtures, and in various strengths of chromic. The latter reagent was most useless of all, as it was a long time before the activity of the tubes was overcome. After trying a great many things I was only able to preserve the organs in their normal condition in 1 per cent. osmic acid and in a mixture of corrosive sublimate and osmic acid. Jourdan (4, p. 43) mentions some similar experiences.

It is obvious that here there can be no question whatever of the elongation being due to pressure of fluid. The Cuvierian tubes each possess a sort of automatic power of rapidly elongating, the explanation of which must be sought for in the structure of the organs themselves, and which therefore I am not able at present to give. Hence I mistrust Hérouard's experiment, for in *Holothuria nigra* the organs can be made to elongate whether the cloaca be ligatured or not. Nevertheless it would seem, from the combined evidence of Semper and Hérouard, that in some forms the Cuvierian organs are capable of dilating and contracting in response to

pressure of fluid from the cloaca; but that is certainly not the case in *Holothuria nigra*. In this form the organs elongate entirely of themselves in response to stimuli, which may be applied to the organs themselves or to the peripheral sense-organs of the animal, which is the normal process. Moreover, when once the organ has elongated it cannot be again retracted, but is cast off, a constant supply of such organs being kept up by outgrowths from the respiratory tree. Examination of isolated organs shows that the elongation and the formation of the sticky thread commence at the base, and that the "head" which rushes about so wildly in the water is the remains of the original Cuvierian organ. In normal healthy cases the head becomes entirely used up in the formation of the sticky thread; but often its power slackens and stops while a great deal is still unused. As the energy gets less the thread produced is not straight, but wavy, as in fig. 1 *b*. This can well be seen by putting the organs in corrosive sublimate or Kleinenberg's picric, when the wavy appearance is produced as the reagent gradually overcomes the power of elongation.

To resume, the following appears to be the normal process. Irritation of the skin of the Holothurian is transmitted ultimately, along what nerve-paths I cannot say, to the base of Cuvierian organs. Certain of these commence to elongate with great rapidity, in what way is not clear—most probably as described by Jourdan, but certainly not as the result of pressure of fluid. As a result they soon find their way out of the body and continue to elongate outside, being generally directed by the animal, so that some of the tubes are almost certain to come in contact with, and stick to, the irritating body or foe. After this they break off at their point of attachment to the respiratory tree, and new organs grow to replace them.

The next point to examine is the

3. *Ejection of the Cuvierian Organs*.—The problem here may be briefly stated as follows. The Cuvierian organs are attached to the respiratory tree and lie entirely in the body-cavity, with their free ends pointing away from the anus. When ejected they emerge from the anus with the free end foremost. To do this it is obvious they must in some way pass through the wall of the gut.

According to Semper (7) they come through an opening in the wall of the cloaca with their free end foremost. It is left an open question whether the opening they pass through is pre-formed or arises by dehiscence at the time the organs are thrown out. Ludwig (5, p. 401) considers that our anatomical knowledge

points to the latter view. Hérouard seems to agree with Semper, for he states that the whole process is the first act of expulsion of the digestive tract, and that when the wall of the cloaca is torn the Cuvierian organs, being nearest to it, are thrown out.

On the other hand, Cuénot (2, p. 371) has a more complicated theory. He says:—"As Hérouard has shown, the water enclosed in the cloaca penetrates into the basilar vesicles [which in *Holothuria nigra* do not exist], and from thence gradually into the tubes, which dilate little by little, this dilatation coinciding with the contraction of the irritated animal. The pressure in the interior of the body increases; the tubes tend to be rejected to the exterior; at this moment, it is a point which escapes direct observation, they break at their base of insertion on the basilar vesicle, which presents probably a *locus minoris resistentiæ*, pass through it and the cloaca, and are rejected by the anal orifice. The basilar vesicle then contracts, the strong muscular walls apply themselves to one another, so interrupting all communication between the coelome and the exterior."

. If I have understood this description properly I gather that the Cuvierian organs break off completely at their bases of insertion and then pass bodily through the hole thus made. I further infer from it that the Cuvierian organs should emerge with their bases foremost. All these statements are negatived by the facts observed in *Holothuria nigra*. The organs do not emerge with their bases foremost and they do not break off from their attachment until they have spent themselves and are firmly fixed to some object, when they are violently broken away from their attachments to the respiratory tree by the animal's movements.

I have had many opportunities of studying the method in which these organs are rejected, and can completely confirm Semper's account. While opening *Holothurians* to obtain gregarines a great number of Cuvierian organs were always ejected by them, and in such specimens an aperture in the dorsal wall of the cloaca could always be found, and very often Cuvierian organs would be found in the aperture. After many attempts I was able to make and draw the dissection shown in Plate XVII. fig. 9, in the following manner:—A fresh *Holothurian* being obtained, it was placed on a sheet of cork and made to eject some Cuvierian organs. Then with a sharp knife the body was opened on the right side by a longitudinal cut and the integument pinned out right and left. Weak spirit was then poured on to the surface of the water, in order to subdue the action of the powerful body-

muscles, which tend by their contraction to curl up the cut integument and pull out the pins. When the muscles were thus stupefied the dissection was carefully proceeded with, and when finished placed in strong spirit. In this manner the result was obtained shown on Plate XVII. fig. 9. The Cuvierian organs (*c.o.*) are seen lying in a great mass attached to the left respiratory tree (*l.rsp.*). Some of them (*c.o.*!) have detached themselves from the main body and have passed through an opening in the dorsal wall of the cloaca and out through the anus to the exterior.

To confirm the results so obtained I employed another method. In the store of the Marine Biological Association there were a great number of specimens of *Holothuria nigra* preserved in spirit, many of which had in dying partially ejected their Cuvierian organs and were to be seen with a bunch of these organs protruding from the anus. Selecting such a specimen, I cut a series of thick sections through the cloacal region with the hand, using a sharp razor and arranging the sections in order. I obtained nine such sections through the cloaca and the base of the respiratory trees, and in figs. 2-8 on Plate XVII. seven of them are diagrammatically represented.

In the first section (fig. 2) the cloaca (*cl.*) is seen filled with Cuvierian organs (*c.o.*) and attached to the body-wall (*int.*) by radiating muscles. The five longitudinal muscles are just visible. The third and fourth sections (figs. 3 and 4) are similar but larger, and the number of Cuvierian organs is greater. In the fifth section (fig. 5) the Cuvierian organs are now close up against the dorsal wall of the cloaca; a few appear also entangled in the cloacal muscles to the left and ventrally. In the sixth section (fig. 6) the wall of the cloaca is wanting on the dorsal side, and the gap is filled by Cuvierian organs which are oval in section, showing that they are cut obliquely and are hence passing downwards and backwards. The seventh section (fig. 7) passes through the spot where the cloaca gives off a branch, the left respiratory tree (*l.rsp.*), to which the Cuvierian organs are beginning to be attached. It is noteworthy that dorsally some of the Cuvierian organs are cut twice in the section, and can be seen in fact to bend backwards, curving slightly to the right. In the eighth section (fig. 8) the respiratory tree is quite distinct from the rectum, which is placed more ventrally and attached by a mesentery between the median and right ventral longitudinal muscles. A great number of Cuvierian organs are attached to the respiratory tree, and a similar curving back can be observed in some of them to that pointed out in

the preceding section. The ninth section (not figured) was almost precisely similar to the eighth. In all the sections the delicate right respiratory tree has been lost, having been probably torn away by the razor.

The conclusion I draw from these preparations is as follows:—The Cuvierian organs, after commencing to elongate within the body in the manner described above, are in some way directed to the dorsal wall of the cloaca, which they break through. It may be that the powerful contraction of the body-walls, compressing the liquid contained in the coelome, causes the wall of the body-cavity to break at its weakest point, which is presumably the dorsal wall of the cloaca, through which the organs are then forced. Bell has also observed Cuvierian organs in the cloaca of one of his specimens of this form (1, p. 375). They thus reach the anus, from which they issue point foremost, to elongate in the surrounding water. I have frequently found that pieces of the cloacal wall, recognizable by their radiating muscles, are ejected with the organs, and have no doubt that the aperture in the cloaca through which they escape is temporary. An interesting experiment would be to stimulate a Holothurian to eject its Cuvierian organs after first ligaturing the anus, so that they would be unable to escape by the usual path, and would be obliged either to find some other mode of exit or remain within the body-cavity.

4. *Function of the Cuvierian Organs.*—The greater number of authors consider them as organs of defence. Peach (6, p. 173) described in 1845 how the animal “is extremely irritable, and on being touched or disturbed throws out a bunch of white tapered threads about an inch in length and one eighth in thickness; these soon become attenuated, either by the agitation of the water or the coming into contact with something; they stick to everything they touch, and from that the animals are called ‘cotton-spinners’ by the fishermen.” Ludwig, in his magnificent work ‘Echino-dermata’ (5, p. 401 *et seq.*), sums up the views of different authors and inclines to the view that they are organs of defence, though a little uncertain as to whether that is their primitive function, owing to the statements of Hérouard. Cuénot also argues strongly that they are a means of defence (2, p. 372 *et seq.*). Hérouard alone of recent writers expresses his views to the contrary in the following words (3, p. 673):—“Les tubes de Cuvier sont considérés actuellement comme étant des organes de défense. Partisans des causes finales, les auteurs ont attribué à ces organes de telles fonctions, parce qu’ils adhèrent remarquablement aux objets qui les

touchent. L'observation des faits contredit cette manière de voir. Les tubes de Cuvier sont simplement des organes arborescents transformés, éminemment extensibles et contractiles, adaptés à des fonctions glandulaires spéciales."

At the risk of being considered by M. Hérouard as a "partisan of final causes," I must express my opinion that in the Cuvierian organs we have to do with organs of defence. I do not hold this belief because these organs are remarkably sticky, any more than I believe that a pistol is a weapon of defence because it is hollow; but because I have seen them in action, which M. Hérouard does not seem to have done. After denying them a defensive function, M. Hérouard terms them glandular organs; but, as Ludwig (5) remarks, it is difficult to reconcile this idea with their structure, since the glandular layer is separated from the lumen by connective tissue. Moreover, the ejection of these organs in *Holothuria nigra* is in no way a pathological process, as M. Hérouard supposes, but a perfectly normal act. There can be no reasonable doubt, it appears to me, that in the species here under consideration the Cuvierian organs function only as weapons of defence*. Nevertheless it is quite possible that they may not have this function universally in the group of Holothurians and may have primitively served some other function. In fact the Cuvierian organs of *Bohadschia marmorata*, as described by Semper (7, p. 139), can hardly be used for defence in the same way as those here described.

In considering the question it should be borne in mind that, while these organs may be highly developed in one Holothurian, they may be altogether wanting in another closely allied form. Thus they are quite wanting in *Holothuria tubulosa*, which is a close ally of our form. This fact seems to me to go against the idea that they represent in any way a morphological rudiment, *i. e.* an organ which formerly had some other very different function. Their position and mode of growth shows them to be simply outgrowths of the respiratory trees. In some Holothurians they are, as is well known, racemose or "traubenförmig." In such forms therefore they would appear to be less differentiated from the remainder of the respiratory tree than in forms like *Holothuria nigra*, where they are highly specialized. These facts

* In Naples I was able to observe the large *Holothuria sanctori*, which emits its organs in the same manner as *H. nigra*. The Cuvierian organs are smaller in this form than in *H. nigra*, and, owing to the great thickness and muscular power of the integument, they are more difficult to study in the living animal.

point to the Cuvierian organs being simply, as Hérourard supposes, a modified portion of the respiratory tree.

The habit possessed by so many Holothurians of ejecting the intestines when stimulated is too well known to require description. This evisceration seems to be almost a normal habit, since viscera of Holothurians are frequently fished up by fishermen. At Plymouth I often offered ovaries and other portions of the viscera of Holothurians to anemones and other animals in my tank. I did not keep any careful record of my experiments; but I can only say that the viscera were often immediately swallowed by anemones or seized hold of by other animals, but always rejected again in a few minutes. The impression I obtained was that these viscera were extremely unpalatable to the majority of animals. I think this idea, if carried out by further experiments, would give us some clue as to the use of this curious habit. If any rapacious dogfish or other animal attacked a Holothurian and caused it to eject its viscera, it would in all probability, after tasting them, never repeat the experiment*. The Holothurian, on the other hand, appears to suffer but little harm from its evisceration, since it is certain that the whole of the viscera can be regenerated under normal conditions. Nevertheless the habit of throwing out all the viscera must be an exceedingly expensive one, and the view I take of the Cuvierian organs is that they are simply *a portion of the viscera specially modified for ejection*. Their position, near the base of the respiratory tree, is one where they would be the first organs to be ejected, as Hérourard has remarked. Their anatomical relations show them, as stated above, to be only specially modified portions of the respiratory tree. Possibly they at first retained their respiratory function and were only distinguished by the possession of an external layer of mucous secreting gland-cells, which increased their unpalatability. At first merely passively offensive, they ultimately by further modification became aggressively so, as in *Holothuria nigra*. The steps from such an hypothetical initial stage to the highly modified organs of the latter form it is not in my power to trace. Before that could be done more information is necessary as to their structure and the exact method in which their elongation is brought about in this and other forms.

* Here one may draw attention to the intensely bright coloration of the internal organs of Holothurians, which are certainly exceedingly conspicuous objects when ejected. May not this probably be a case to be brought under the heading of "warning coloration"?

The above theory of the function and origin of the Cuvierian organs is, I am well aware, an hypothesis only, and requires much more foundation before it can be accepted. Nevertheless, on the principle that the test of an hypothesis is its power of explaining facts, I venture to bring it forward as a suggestion as to the true nature and homologies of these very curious and interesting organs.

Oxford,
July 1892.

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EXPLANATION OF PLATE XVII.

Figs. 1 a & b. Two Cuvierian organs as seen during the process of elongation and production of the sticky thread. *h*, “head” or remains of the original organ, which is being used up to form the thread (*thr.*) at the point *x*: *1 b* is drawn from an organ which had gone off on being placed in Kleinenberg's picric. Natural size.

Figs. 2-8. Seven sections taken from a series of nine thick sections through the posterior end of a *Holothurian* which had commenced to eject its Cuvierian organs on being placed bodily in spirit. Represented somewhat diagrammatically and slightly enlarged. Lettering for all the figures:—*int.*, integument; *l.m.*, longitudinal muscles; *cl.*, cloaca; *c.o.*, Cuvierian organs; *l.resp.*, left respiratory tree; *r.*, rectum.

Fig. 9 represents the posterior part of a specimen of *Holothuria nigra*, opened while in the act of rejecting some of its Cuvierian

organs. The body was opened a little to the right of the mid-dorsal line. In the middle are seen the three longitudinal muscles of the trivium (*tr.*). On the right is the right muscle of the bivium (*r.bv.*), and on the left is the left one (*l.bv.*). The Cuvierian organs (*c.o.*) are seen forming a great mass attached to the left respiratory tree (*l.rsp.*), which is attached by a mesentery to the rectum (*r.*). Some of the Cuvierian organs (*c.o.*) are seen passing through an aperture in the wall of the cloaca (*cl.*) and protruding from the anus (*an.*). On the right is seen the right respiratory tree (*r.rsp.*), the extremity of which has been loosened from its attachments and hangs over the side of the dissection.

XXXII.—*Descriptions of some new Species of African Lepidoptera.* By W. J. HOLLAND, Ph.D., F.E.S., Pittsburgh, U.S.A.

RHOPALOCERA.

Nymphalidæ, Swains.

Genus *Thaleropis*, Staudinger.

1. *Thaleropis trigona*, sp. n.

♂. Antennæ black above, brown below. Front white; eyes brown; palpi black above and whitish below; collar and thorax black, spotted with yellow. The end of the abdomen is yellow above and tipped with black. The underside of the body is bluish grey. The anterior wings are strongly arched on costa, produced and rounded at apex, strongly excavated upon the outer margin, with the outer angle scarcely rounded and the inner margin straight. The costa of the posterior wing is one fourth shorter than the inner margin of the anterior wing; the outer margin is very convex and produced at the anal angle in the form of a short and broad tail. The markings of the upper surface resemble those of *T. kinugnana*, Grose Smith, but the macular bands of yellow traversing the median area of both wings differ from those of all other species hitherto described in that they are subtriangular in form, increasing in width from the costal region towards the inner margins of the wings; and there are no subcostal yellow spots as in *T. kinugnana* and *T. uhelda*. The markings of the underside are much as in *T. (Pseudacrea) uhelda*, Mabille, but the base of the posterior wing is umber and the median transverse band of this wing

is broader and darker than in that species and is divided in the middle by a line of light grey.

Expanse of wings 50 millim.

Hab. Lake Onauga, Gaboon, W. Africa.

The type is in the collection of the author and is unique.

Note.—*T. kinugnana*, *T. uhelida*, and *T. trigona* are not strictly referable to *Thaleropsis*, and should compose a new genus.

Lycænidæ, Steph.

Genus PENTILA, Westw.

2. *Pentila umbra*, sp. n.

♂. Recalling *P. rotha*, Hew., in the general style of its markings, but differing in the arrangement of the spots in the cell of the fore wing and in the greater breadth of the black outer margins, and in the peculiar dull wood-brown ground-colour of the wings above and below.

Expanse of wings 38 millim.

Hab. Upper valley of the Ogové (or Ogowé).

Type in Collection Holland.

D'URBANIA, Trim.

3. *D'Urbania cornu-copiae*, sp. n.

♂. Antennæ, head, thorax, and abdomen black on the upperside, grey on the underside. The ground-colour of the upperside of both wings is a warm red, restricted upon the primaries to a curved median band widening from about the middle of the costa to the outer angle and the middle of the inner margin, and presenting the outline of a "horn of plenty." The remainder of the primary is dark brown. The posterior wing is irregularly margined outwardly and profusely speckled upon the inner margin with dark brown. Upon the underside of the primaries the red curved fascia reappears, but the colour is less brilliant than upon the upperside. The costa and the apex of the primaries are broadly lilac-grey, minutely spotted with brown; the base and a transverse subapical band are fuliginous. The posterior wings are of the same lilac-grey colour as the apical portion of the primaries, and are mottled with small brown spots and traversed beyond the cell by an irregularly curved narrow black line, and further ornamented upon the margin by subhastate brown spots disposed upon the intraneural spaces.

Expanse of wings 24 millim.

Hab. Ogové Valley, Gaboon, W. Africa.

Type in Collection Holland.

Genus LACHNOCNEMA, Trim.

4. *Lachnocnema Reutlingeri*, sp. n.

♀. Body and wings dark brown above. Both wings are crossed beyond the cell by a broad, oblique, macular band of pale yellow curving inwardly. The ends of the cells are marked by heavy black spots. Upon the underside the markings are as in *L. bibulus*, Fabr., but larger, darker, and more distinctly defined upon the much paler ground-colour, except the median macular band of the secondaries, in which the spots are paler and red in tone, and heavily margined with silver externally.

Expanse of wings 44 millim.

Hab. Benita.

Type in Collection Holland.

This species may be readily distinguished from all others of the genus by its large size and the pale yellow bands of the upper surface.

Genus HYPOLYCÆNA, Felder.

5. *Hypolyccæna rava*, sp. n.

♀. Upperside dark brown, with an oval orange spot below the cell in the primaries, and the outer third of the secondaries from below the outer to the anal angle likewise orange. The margin of the secondaries is dark brown and the orange area is interrupted by a small circular brown spot just beyond the tail, which is black and minutely tipped with white. The underside has the markings somewhat as in *H. eleala*, Hew., which are characteristic of a large group of African species belonging to this and allied genera.

Expanse of wings 28 millim.

Hab. Kangwe, Ogové River, W. Africa.

Type in Collection Holland.

Genus PSEUDALETIS, Druce.

6. *Pseudaletis nigra*, sp. n.

♀. The upper surface is black. On the primaries there is a small white spot at the end of the cell and a moderately broad white subapical band running from before the middle

of the costa, which it does not reach, to below the middle of the outer margin, which it likewise does not reach. Upon the secondaries there is a large white band running from the upper part of the base outwardly and covering the cell, and extending about three fourths of the distance from the base toward the outer margin, which it does not reach. The inner edge of this band is straight and the edge toward the costa is regularly curved. There are two or three blue spots at the anal angle near the tail, which is black. The underside of the primaries has the same markings as the upper, and in addition a subapical white spot beyond the subapical band, and between these a faint curved bluish line. Upon the underside of the secondaries, in addition to the white central band, there are toward the outer margin two faint bluish-white lines converging near the outer margin at the outer end of the broad band. The outermost of these lines is dilated above the third median nervule, and shows a faint white spot at this point. The inner margin and anal extremity of the wing is washed with yellowish olivaceous, and there are two short silvery blue bands bordered with black upon the inner margin, and two black spots outwardly margined with silvery blue at the origin of the tail.

Expanse of wings 45 millim.

Hab. Kangwe, Ogové River, West Africa.

Type unique, in Collection Holland.

Papilionidæ, Leach.

Genus PAPILIO, Linn.

7. *Papilio policenoides*, sp. n.

♂. Having the general appearance of *P. policenes*, Cram., but the green bands which cross the cell of the primaries, except the one nearest the base, are obsolete, and the row of large green spots composing the limbal fascia are more uniform in size than in *policenes*, and the second spot from the inner margin is very feebly produced inwardly at its upper edge, and in some specimens is quadrate. Upon the underside the spots are much reduced in size and the general colour is much blacker than in *policenes*, and the arrangement of the bands is different in important particulars. This may prove to be a seasonal or dimorphic form of *policenes*.

I have a large series of specimens showing great constancy in the markings.

Hab. Talaguga, upon the Upper Ogové.

Type in Collection Holland.

Hesperidæ, Leach.

Genus SARANGESA *, Moore.

Sape, Mabilie (nec *Sapæa*, Ploetz).*Erites*, Mabilie.*Hyda*, Mabilie.8. *Sarangesa perpaupera*, sp. n.

♂. The upperside is prevalently dark fuscous, with darker cloudings near the margins and a few obscurely defined dark spots and bands on the limbal area of both wings. There is a large black spot at the end of the cell and two minute translucent subapical spots near the costa of the primaries. The underside is much as the upper, but paler, and the markings of the upperside are reproduced upon the lower side, but are still more obscure. Lower side of palpi greenish grey.

Expanse of wings 27 millim.

Hab. Valley of the Ogové.

Type in Collection Holland.

9. *Sarangesa motozioides*, sp. n.

♂. Resembling *S. motozi*, Wallengr., but may be distinguished by the fact that the lower wing is broadly yellow upon the underside except at the outer angle and the costa, which are brown. The wing is also traversed by a subbasal and median curved band of small spots.

♀. Much darker than the male upon the lower surface and paler than upon the upper surface of the male. The translucent vitreous spots in this sex are also much larger, especially the spot near the origin of the second and third median nervules, which is relatively very large and subquadrate.

There are numerous other minor points of distinction between this species and the true *motozi*; but the prevalence

* Mons. P. Mabilie has recently created a genus under the name *Hyda* for the reception of his species *micæa* and *tricerata*, and another genus, to which he gives the name *Erites*, and to which he refers *djelalæ* and allied species. He has also referred to a genus *Sape* (? = *Sapæa*, Ploetz) *motozi* of Wallengren and allied forms. A thoroughly critical examination of the neurulation and sexual organs of these species made by Mr. Watson at the British Museum shows that they are all truly referable to the genus *Sarangesa* of Moore, and therefore *Hyda* and *Erites* of Mabilie sink as synonyms. The type of *Sapæa*, Ploetz, is *Abantis bicolor* of Trimen, which is strictly congeneric with *A. tectentis*, Hopff., the type of *Abantis*. Therefore *Sapæa* likewise falls.

of the yellow colour upon the underside of the secondaries will easily enable the student to distinguish the species.

Expanse of wings 33 millim.

Hab. Valley of the Ogové.

Types in Collection Holland.

Genus PARDALEODES, Butl.

10. *Pardaleodes xanthopeplus*, sp. n.

♂. Head and body greenish fuscous, lighter beneath. Fore wings above dark brown, with the base heavily clothed with greenish hairs. Two small spots at end of cell, of which the upper one is the largest; two small subapical spots, of which the lower one is the largest; three small subhastate spots, one above the submedian and one on each of the median interspaces, forming a series of which the middle spot is the largest. All these spots are orange-yellow. The hind wings are heavily bordered above upon the costa with black, which extends over the base and the cell, where there is a small orange spot. The black of the base is partly concealed by a heavy vestiture of greenish hairs. The remainder of the hind wing is bright orange-yellow, and the fringe is of the same colour except just below the outer angle, where it is feebly shaded with brown. Upon the underside the dark portions are more subdued and the lighter portions of the wings not so bright as upon the upperside, and the spots are larger. In addition, upon the anterior wing there is a marginal shade of light fuscous. Upon the posterior wing there are two small yellow spots in the dark costal band, the yellow spot at the end of the cell reappears below as a bifid spot, and there are a few cloudy brown marks in the broad yellow outer margin of the wing.

♀. In the female the spots upon the upperside of the primaries are greatly increased in size. The spots on the cell coalesce and form a large quadrate spot bifid at either end, while the middle spot of the submarginal series is greatly increased and extended toward the cell, coalescing, save for the dark median nerve, with the spot in the cell. In the secondaries the orange-yellow outer margin of the male is contracted into an irregularly oval spot upon the limbal area beyond the cell. Upon the underside the spots are very much as in the male, but larger and conforming to the modifications already noticed as occurring upon the upperside.

Expanse of wings 38 millim.

Hab. Valley of the Ogové.

11. *Pardaleodes astrape*, sp. n.

♂. Uppeside of body fulvous, more or less clothed with greenish hairs. Underside of palpi and thorax greenish grey. The prevalent colour of the outer half of the anterior wing is deep black and of the basal half tawny. The base is more or less clothed with greenish hairs. There is a black longitudinal ray in the cell and another just below it at its outer extremity. At the end of the cell there is a double translucent orange-yellow spot, a similar smaller spot below the apex, and two larger spots located upon the median interspaces just below and beyond the cell. The posterior wing is bright orange-yellow, with the costal margin broadly and the inner margin and the outer margin from the outer angle to the first median nervule narrowly black. The fringe is orange. Underside: The anterior wing is honey-yellow from the base to the apical region. The apex and outer margin are broadly ferruginous. The translucent spots of the upper surface reappear. Below the cell near the base there is a heavy black ray, below this a large sagittate lemon-yellow spot with the point toward the base, and covering the middle of the inner margin; this spot and the two translucent spots above it are shaded externally by clouded black markings, deepest in colour at the outer angle. The posterior wing is uniformly orange-yellow, paler than the upperside and without markings, save that the margin from the outer angle to the first median nervule is narrowly margined with pale brown, and just where this marginal shade terminates there are two small submarginal brown spots.

Expanse of wings 28 millim.

Hab. Gaboon.

Type in Collection Holland.

12. *Pardaleodes xanthioides*, sp. n.

♂. Resembling *Carystus* * *xanthius*, Mab., but fully one third smaller in size. The markings are as in *xanthius*, but at the base of the primaries near the inner margin there is a broad yellow ray with a round black spot near its extremity, and the black margin of the secondaries is more even and the yellow enclosed area rounded on the side of the costa, and not nearly straight, as in *xanthius*. Upon the underside the

* I find that the neururation and the structure of the palpi and antennæ of *Carystus xanthius*, Mab., and of the present species do not differ appreciably from *Pardaleodes*. While *xanthius* is a much larger insect than any other species of *Pardaleodes* known to me, it certainly is not a *Carystus*.

basal yellow ray of the primaries does not reappear. The colour of the secondaries is yellow as upon the upper surface, and not whitish as in *xanthius*. There is no black upon the costa. The border of the outer margin is uniformly brown, slightly produced at the first median nervule. There is a very small brown spot below the cell halfway from the base near the inner margin.

♀. Like the male, but lacking the yellow basal ray on the primaries.

Expanse of wings 32 millim.

Hab. Valley of Ogové River.

Type in Coll. Holland.

Genus OSMODES*, Watson, MS.

13. *Osmodes lux*, sp. n.

♂. Head, thorax, and abdomen brown above, more or less clothed with shining fulvous hairs. Palpi, thorax, and end of abdomen below greenish grey. Upperside: Anterior wing black, with the basal half of costa and base suffused with greenish fuscous; at the end of the cell there is a bright fulvous spot, at the apex a large subquadrate spot of the same colour, and below it a broad transverse band of the same colour running from above the third median nervule to the middle of the inner margin and indented between the submedian and first median nervule. The posterior wing is bright fulvous, very heavily bordered on the costa with black, the black area being extended inwardly at the end of the cell, which it partially covers. The margin is bordered with black, which is produced inwardly just above the slightly lobed anal angle. The inner margin is more heavily bordered with black. The sexual brand is slightly darker in colour than the body of the wing and is oval in form. The underside is pale brownish. The spots of the upperside reappear upon the primaries. Upon the underside of the secondaries the basal half is dark brown and the limbal area washed with yellow, and the outer and inner margins clouded with pale brown. There are four silvery-white spots margined with dark brown upon the wing—one on the cell, one near the middle of the costa, one beyond the cell, and one between the first and second median nervules.

* The type of this new genus, which Lieut. Watson has erected, is *Pardaleodes laronia*, Hew. The genus may be recognized by the sexual brand upon the cell of the posterior wings of the males. It includes, among other species, *laronia*, Hew., *adon*, Mab., *thora*, Mab., and *argenteigutta*, Mab.

♀. The female is marked upon the upperside as the male, but the wings are much blacker and the spots are reduced in size, and the margin of the secondaries is much more heavily bordered with black. Upon the underside the primaries are blackish except the basal end of the costa and the apex, which are pale brownish. The spots upon this wing are as in the male. The secondaries have, in addition to the four silvery spots which are found in the male, two small additional spots closely collocated between the two outer spots, which are larger than in the male. The submarginal area is yellower than in the male. The margin is indicated by a fine brown line, the fringe is yellow and is chequered with brown at the ends of the nervules from the outer angle as far as the first median nervule.

Expanse of wings 30 millim.

Hab. Valley of the Ogové.

Type in Coll. Holland.

Genus TENIORHINUS*, Watson, MS.

14. *Teniorhinus Watsoni*, sp. n.

♂. Head, thorax, and abdomen dark brown above; palpi greyish below, thorax and abdomen dull luteous below. Upperside: Wings dark brown, nearly black; upon the primaries a faint subapical longitudinal streak and an irregular oblique transverse band beyond the cell extending from third median nervule to before the middle of the inner margin. Upon the secondaries a broad transverse band beyond the cell, running from near the middle of the outer margin below the cell, and continued upward toward the base as a narrow line. The inner margin fold is clothed with fulvous hairs. All the spots of the upper surface are bright fulvous. Underside: Both wings are pale tawny, with the spots of the upper surface reproduced and pale yellow, more or less translucent when held up to the light. Upon the primaries there is a black longitudinal shade upon the cell, and at its extremity a quadrate spot of the same colour, and upon the middle of the outer margin a similar shade.

Expanse of wings 23 millim.

Hab. Gaboon.

Type in Coll. Holland.

* This genus has been erected by Lieut. Watson to receive this and allied species of small size, characterized by slender and widely separated palpi porrected and recurved, and with the apex of the anterior wing rounded.

Genus OXYPALPUS*, Watson, MS.

15. *Oxypalpus annulifer*, sp. n.

♂. Head and body dark brown above, lighter below; palpi and breast greyish. Wings above very dark rich brown, spotted with dark fulvous. The spots are as follows:— Upon the primaries a small subapical spot; a small linear spot at the end of the cell near the lower edge; three sub-hastate spots forming an oblique discal series beyond the cell, the middle spot, which is the largest, immediately adjacent to the small spot in the cell, a short basal ray on the inner margin. Upon the secondaries there are two linear spots beyond the cell upon the median interspaces near their origin, forming a short fascia at right angles to the inner margin. The fringes are dark fulvous and the fold of the inner margin is marked by fulvous hairs. Upon the underside the primaries are much lighter than upon the upperside. The costa at the base and the apex are brownish grey. The spots of the upperside are reproduced, but much larger and less sharply defined. The secondaries upon the underside are dark ferruginous brown, shading near the middle of the inner margin into yellowish brown. The costa near the base is blackish. There are two minute black spots near the base and a median and a submarginal transverse band of blackish annular spots. The margin is bordered with black, heaviest at the anal angle. The fringes are fulvous.

Expanse of wings 32 millim.

Hab. Ogové Valley.

Type in Coll. Holland.

Genus PROCAMPTA †, gen. nov.

16. *Procampta rara*, sp. n.

♂. The prevailing colour of the body and wings above and below is dark umber, lighter below and darkest upon the

* The type of this genus, which will shortly be published by Lieut. Watson, is *Pamphila ignita*, Mabille.

†

PROCAMPTA, gen. nov.

Allied to *Anisochoria*, Mab. Body slender. Palpi moderately long, slender, porrect, appressed, with the second article heavily clothed with hairs and the terminal article slender. Fore wing rounded at base, convex on middle of costa, and slightly concave before apex; apex truncate outer margin straight; outer angle not rounded, inner margin straight. Posterior wing subpyriform and very convex on outer margin.

Type *P. rara*, Holland.

upperside of the secondaries. The wings are marked with moderately large black spots, one at the end of the cell in the primaries followed by a median and submarginal band of spots. Upon the secondaries the spots are arranged as a basal, median, and submarginal transverse series. In addition, upon the primaries there is a very minute translucent spot near the end of the cell and a subapical series of three similar spots, two just below the costa and on a line at right angles to it and the third a little below and beyond the second spot.

Expanse of wings 33 millim.

Hab. Ogové Valley.

Type, which is unique, in Coll. Holland.

Genus *TRICOSEMEIA* *, gen. nov.

17. *Tricosemeia subolivescens*, sp. n.

♂. Both wings and body deep black above, with the hairy patch upon the secondaries sooty and the shining area upon the costa of the secondaries testaceous. Near the apex of the primaries just below the costa are four minute translucent spots forming a quadrilateral, and below these, just above the third median nervule, a similar spot. Upon the underside the primaries are brown outwardly, the basal area is testaceous, with a broad patch of sooty scales at the lower basal edge of the cell, which they partly invade. The costa at the base is olivaceous. The posterior wing below is broadly yellowish olivaceous; the fringes are brown on the outer margin, there are two short and narrow parallel brown lines at the end of the cell, and a curved fascia of five brown spots running parallel to the margin from above the middle of the cell to above the third median nervule. The second spot from the direction of the base in this series is the largest. Lower side of body olivaceous.

Expanse of wings 33 millim.

Hab. Matabele Land.

Type in Coll. Holland.

*

TRICOSEMEIA, gen. nov.

(*θρίξ, pilus*; *σημείον, signum*.)

Near *Tagiades*, Hübn. Body slender; antennæ half as long as costa of anterior wing, slender, swollen and slightly recurved at tip. Palpi short, very hairy, and the last article short and slender and nearly hidden in the hairy vestiture of the second article. Fore wing subtriangular, with the costa and the outer margin very convex and the inner margin straight. Posterior wing subpyriform, the costa produced or lobed near the base; the outer margin convex and the inner margin gently rounding

XXXIII.—Description of a new Genus and Species of African Moths. By A. G. BUTLER, F.L.S., F.Z.S. &c.

THE following very remarkable new genus is so aberrant that, although there can be little doubt that it is distantly related to *Hypena*, no nearly allied form has been recorded; in the form of its wings it somewhat resembles the males of the Erosiid genus *Dirades*, with which, however, its structure in no respect corresponds.

I propose to name this wonderful novelty, in honour of its zealous and learned owner,

HOLLANDIA, gen. nov.

Primaries very broad, the costal margin arched at base, very nearly straight (if anything slightly concave) to near apex, where it is again convex, and passes almost imperceptibly into the outer margin; the latter very convex, but forming a nearly straight oblique line from third median branch to external angle, which is rather acute; inner margin slightly convex. Costal vein extending nearly to apex; subcostal five-branched, the first branch emitted before the end of the cell, the three following near together at some distance beyond it, the second and third being slightly curved upwards at costal margin, the fifth emitted, with the upper radial, from anterior angle of cell; lower radial emitted close to the second and third median branches from the posterior angle of the cell. Secondaries comparatively small, with the costal margin widely arched and forming its apex at end of third median branch; the costal and subcostal veins, which anastomose at base, consequently curving upwards to costal margin; outer margin nearly straight; abdominal margin obtusely elbowed; a large sericeous pyriform sexual patch on upper surface crossed by the radial and second and third median branches; discoidal cell very short, with the discocellular veinlet transverse and very slightly concave; the

toward the anal angle. A broad patch of raised scales upon the middle of the posterior wing above, and the costa of the posterior wing with the scales closely appressed, presenting a shining silky surface. Upon the underside of the primaries a similar arrangement of the scales is found at the base and the basal end of the inner margin, and in the midst of this shining area there is a large patch of raised scales partly covering the cell.

Type *T. subolivescens*.

radial emitted from the posterior angle of the cell and close to the second and third median branches, which are emitted from a well-defined footstalk; submedian and internal veins converging at their distal extremities.

Body moderately robust; the abdomen barely extending beyond the anal angle of secondaries in length; palpi long, compressed and obliquely porrected; the second and third articles being nearly in line, the second expanding from the base forwards, its inferior fringe extending forwards below the third article, which is small and subcuneiform; antennæ delicate and finely ciliated; legs rather long, the tibiæ terminating in tufted expansions, those of the third pair of legs with a similar expansion in front of the first pair of spurs; base of ventral surface of abdomen hollowed and grooved, the surface in front of the excavation being unusually protuberant.

Type *H. sigillata*.

Hollandia sigillata, sp. n.

Primaries above with the basal two fifths whitish buff, faintly suffused with lilacine greyish, sparsely dotted with blackish scales, with one or two leaden-grey markings indicating an obsolete line beyond its centre, terminated by an irregularly zigzag blackish line which interrupts a pearly blackish-margined <-shaped "reniform stigma," the angle of which is filled by a blackish-edged tawny spot; two black discoidal dots, one near the base and the other just beyond the middle of the cell; external area olive-grey, slightly greenish on costal area and otherwise slightly tinted with lilac; an imperfect oblique, zigzag, bronze-greyish stripe from costal third to just beyond the middle of internal margin; a submarginal cupreous-brown macular stripe commencing with lunate markings which gradually change into oval spots; a black dot within the second lunule and a second near external angle, where the stripe has almost disappeared; external area and fringe slightly cupreous: secondaries whitish, tinted with pale buff, which in certain lights is shot with pink; outer two thirds of abdominal area pale greyish buff, black-speckled, traversed by four grey stripes and bounded internally by a streak of pearl-grey spreading along the outer margin; a large pyriform, sericeous, golden tawny patch enclosing a diffused oval blackish spot on its inner edge: body pale buffish white, the head and tegulæ pale buff, speckled with blackish; collar purplish grey; palpi brownish. Wings below paler than above, more densely speckled with black;

primaries with the internal area to second median branch shining silvery white; costa crossed by blackish oblique streaks, indicating the commencement of the lines and stripes of the upper surface; submarginal stripe present but more lunulate than above, with an arched series of four black pupils to the costal lunules: secondaries with the basi-abdominal half white, the abdominal areole pearly; a black spot at end of cell and a group of eight separated by the interno-median fold: body whitish; tibiæ brownish, with darker expansions.

Expanse of wings 46 millim.

Hab. Gaboon.

Type in Coll. Holland.

XXXIV.—*On the Noctuid Genera allied to Hypætra of Guenée.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE genera allied to *Hypætra* have hitherto been in the utmost confusion, M. Guenée having first produced it, not only by associating differing structures under the same name, but by placing closely allied genera under distinct families. As a matter of fact *Hypætra* and its allies are best placed in the Ophiuroidæ of authors (which will take the name of Dysgonioidæ), and will stand between *Chrysorithrum* and *Trigonodes*.

Genus *AVATHA*, Walk.

Avatha, Walk. Lep. Het. xiii. p. 1106.

This genus will include the bulk of the species hitherto included in *Hypætra* and *Anereuthina*, from which they differ in having the third joint of the palpi placed at an obtuse angle to the second instead of in a line with it, and in their somewhat less dilated hind legs; in the pattern of their anterior wings they differ in the less undulated transverse lines and the greater tendency to produce black patches. The type of *Avatha* is *A. includens*. The species in the British Museum are:—

1. *Avatha includens*.

Avatha includens, Walker, Lep. Het. xiii. p. 1107. n. 1 (1857).

Ceylon. B. M.

Our specimen, although not corresponding with Walker's description, was identified by Mr. Moore, who had examined the type in Mr. Saunders's collection from India.

2. *Avatha trigonifera*.

♀. *Hypatra trigonifera*, Walker, Lep. Het. xiv. p. 1411. n. 4 (1857).
 ♂. *Hypatra complacens*, Walker, l. c. p. 1414. n. 8 (1857).

Ceylon and Java. Types in B. M.

I am not satisfied that this is more than a variety of *A. includens*. We have specimens from Java and the Nilgiris of what may be a variety of this species, but in which the pale belt across the primaries terminates just above the submedian vein, its inferior extremity being defined by a black line emitted from the black patch terminating the dark subbasal band.

3. *Avatha curvifera*.

♀. *Hypatra curvifera*, Walker, Lep. Het. xiv. p. 1412. n. 5 (1857).
 ♂. *Ophiusa frontalis*, Walker, l. c. p. 1434. n. 33 (1857).
Achæa expectans, Walker, l. c. xv. p. 1827 (1858).

Ceylon, India, Nilgiris. Types in B. M.

The types differ in nothing beyond size and depth of colour, *H. curvifera* being the darkest, *A. expectans* the smallest, and *O. frontalis* the palest and largest.

4. *Avatha tepescens*.


Athyra tepescens, Walker, Lep. Het. xiv. p. 1417. n. 5 (1857).

Penang. Type in B. M.

5. *Avatha bubo*.

Athyra bubo, Hübner, Zutr. exot. Schmett. figs. 633, 634.
Hypatra condita, Walker, Lep. Het. xiv. p. 1413. n. 7 (1857).

Java (*Hübner*); Ceylon and Nilgiris. In B. M.

We have a species from Borneo very closely related to this, but I think distinct; it is decidedly larger, and the black subbasal band across the primaries is widened into a broad, internally deeply indented belt edged with silvery whitish; the centre of the wing is occupied by a white band bounding the aforesaid belt externally and shading into olive-green below the second median branch; on the inner margin beyond this band is a reversed comma-shaped black spot, thus , and the submarginal area is more lilacine and shows no trace of the zigzag submarginal stripe; the fringe of secondaries is uniform, having no white anal patch, and the head, collar, and tegulæ are ferruginous. Expanse of wings 59 millim.

This species may be called *Avatha pulcherrima*.

HYPÆTRA, Guen.

Hypætra, Guen. Noct. iii. p. 259.

Hypætra noctuoides.

Hypætra noctuoides, Guen. Noct. iii. p. 259. n. 1686 (1852).

Java, Moulmein, N. India, Silhet. Type in B. M.

This and *Anereuthina* are nearly allied genera, having a very robust appearance; in the latter genus, however, the posterior tibiæ are more broadly fringed and the thorax is more humped in front; probably as other species are received it will be found impossible to keep them separate. *Hypætra lilach* of Guenée is unknown to me (Walker and others have called it *H. lilacii*).

ANEREUTHINA, Hübn.

Anereuthina, Hübn. Zutr. exot. Schmett. ii. p. 23.

Anereuthina renosa.

Anereuthina renosa, Hübn. Zutr. exot. Schmett. figs. 325, 326.

Java. In B. M.

This in its pattern reminds one of *Maxula unistrigata*.

ATHYRMA, Hübn.

This genus has hitherto been a muddle of species belonging to several allied genera. They are easily separable by the palpi alone, those of *Athyрма* having a long slender third joint; but in the males of this genus the costa is swollen and embossed before the centre and they have very fine and short ciliations to their antennæ.

Athyрма adjutrix.

Phalæna-Noctua adjutrix, Cramer, Pap. Exot. iii. p. 144, pl. cclxxii. figs. E, F (1782).

Athyрма dormitrix, Guen. Noct. iii. p. 263. n. 1602 (1852).

Brazil, Pará, Tapajos. In B. M.

PSEUDATHYRMA, gen. nov.

Allied to the preceding, but the sigilla on the costa of the males replaced by a large embossed patch within the cell of the primaries, which on the under surface is glazed and tufted; the secondaries with a similar embossed brand on the external area below the second subcostal branch, the veins

being somewhat curved to accommodate it; antennæ minutely and delicately fasciculated.

Type *Pseudathyrma complens* (*Hypætra complens*, Walk.).

1. *Pseudathyrma complens*.

Hypætra complens, Walker, Lep. Het. xiv. p. 1415. n. 10 (1857).

Sumatra. Type in B. M.

2. *Pseudathyrma stigmata*.

Hypætra stigmata, Moore, P. Z. S. 1877, p. 610.

Andamans. Type in B. M.

Of these two species we only possess male examples.

The following genus greatly resembles the preceding, but actually belongs to the Heliothidæ.

BANIANA, Walk.

Baniana, Walker, Lep. Het. xv. p. 1843.

This genus is characterized by a somewhat slender body, often with the collar black, as in *Toxocampa* of the Trifidæ; the antennæ are ciliated, the palpi erect, with a comparatively short third joint. It will include *Baniana luteiceps*, = *Hydrelia semilugens*, *B. mexicana*, *B. significans*, *B. projiciens*, *Poaphila suggesta*, and *Hypætra biangulata*. I need not occupy space by giving full references to these species, nearly the whole of which are described in Walker's 'Catalogue.'

XXXV.—Description of a new Species of *Helix* of the Subgenus *Plectopylis*. By Lieut.-Col. H. H. GODWIN-AUSTEN, F.R.S. &c.

Helix (Plectopylis) Fultoni, sp. n.

Exact locality unknown. Khasi Hills?

Shell sinistral, keeled, widely umbilicated, subglobosely discoidal; colour pale ochraceous; sculpture a fine close flaxy epidermal striation, with four lines of long hairs arranged upon the periphery of the body-whorl—two closely adjacent

and running with the keel above, one around the umbilical depression, and one intermediate. Spire depressedly convex, suture well marked, apex rounded. Whorls seven, closely wound, side of the last very oblique below and flattened, becoming rounder near the aperture, where it descends very slightly. Aperture wide, semioval, very oblique, and slightly reflected on the margin. Peristome not thickened, continuous over the parietal side. The internal barriers are not visible on looking into the aperture. The parietal vertical lamina is simple, with only a slight horizontal support above on the posterior side; a very short double-knobbed horizontal parietal lamella is situated immediately below it. Palatal plicæ double, in two rows, the two apical or highest in position being united together by a low ridge; the posterior row are somewhat obliquely arranged.

Major diam. 20, minor diam. 17.3; alt. axis 8.5 millim.

This fine large species is quite distinct; the arrangement of the palatal plicæ is similar to that of *P. macromphalus* and *P. plectostoma*, while the junction of the two highest palatal plicæ being like that in *P. Andersoni*, its position is intermediate between them (*vide* the characters of this genus given by me in the P. Z. S. 17th November, 1874, p. 612).

It is unfortunate that we do not know the exact locality where this species was obtained; all I can gather is that it was sent to Mr. Fulton by a correspondent who, as he says, "knows nothing about shells, does not collect them himself, but gets natives to do so; the species came to me with *Cyclophorus Pearsoni*, *siamensis*, and *zebrinus*, *Helix* (*Plectopylis*) *plectostoma*, and *Spiraculum hispidum*." All these are Khasi Hill shells, and the last particularly abundant on the limestone at the southern base of those hills. But when shells are collected in this way they may come from any part of Assam, as the recipient gets them in all probability of every one he comes across, and to him distribution is of no importance. Dealers in shells would much enhance the value of their collections if they would be more particular on this point; very frequently the habitat given is quite worthless and terribly misleading. I therefore give Khasi Hills with a query until its true habitat shall be given and on good authority.

XXXVI.—*Descriptions of new Reptiles and Batrachians from the Loo Choo Islands.* By G. A. BOULENGER.

A COLLECTION of Reptiles and Batrachians recently made by Mr. Holst on Okinawa, or Great Loo Choo, contains, in addition to most of those previously reported by me (Proc. Zool. Soc. 1887, p. 146) as obtained by the late Mr. H. Pryer, examples of the following known species and of three which I regard as undescribed :—

Nicoria Spengleri, Gm.; *Eumeces marginatus*, Hallow.; *Dinodon semicarinatus* (= *Eumesodon semicarinatus*, Cope, = *Lepidocephalus fasciatus*, Hallow.); *Callophis japonicus*, Gthr.; *Rana macropus*, Blgr.

Trimeresurus okinavensis, sp. n.

Snout short, obliquely truncate, prominent, with sharp raised angle all round; eye rather small. Rostral deeper than broad, not visible from above; upper head-scales small, juxtaposed or subimbricate and smooth on the snout and vertex, imbricate and obtusely keeled on the occiput; 6 to 9 scales in a transverse series between the supraoculars, which are large, larger than the eye; a pair of scales behind the rostral, separating the internasals in front; three series of scales between the eye and the upper labials; 7 or 8 upper labials, second entering the loreal pit, third largest; temporal scales obtusely keeled. Scales strongly keeled, in 21 or 23 rows. Ventrals 129–130; anal entire; subcaudals 43–47 pairs. Brown above, with darker cross bands or alternating large quadrangular blotches; upper surface of head dark brown, sides blackish, with a lighter streak along the temple; lower parts brown, with a series of blackish blotches on each side, partly on the ventrals, partly on the two lower rows of scales.

Total length 350 millim.; tail 60.

Closely allied to *T. monticola*, Gthr. Distinguished by the somewhat larger eye, the raised canthus rostralis, and the strongly keeled scales.

Rana Holsti, sp. n.

Near *R. temporaria*. Vomerine teeth in two well-developed oblique groups behind the level of the choanæ. Head broader than long; snout rounded, slightly prominent, as long as the diameter of the orbit; loreal region nearly vertical, slightly concave; nostrils a little nearer the end of the

snout than to the eye, the distance between them equal to the interorbital width, which equals the width of the upper eyelid; tympanum very distinct, circular, measuring two thirds diameter of eye and about once and a half its distance from orbit. Fore limb longer than tibia; first finger extending considerably beyond second; tips of fingers blunt, subarticular tubercles strong; a very prominent knob (rudiment of pollex) on inner side of first finger. Tibio-tarsal articulation reaching the eye; tibia slightly longer than foot, half length of head and body. Toes three-fourths webbed, the two distal phalanges of fourth toe free, but with the membrane prolonged as a narrow fringe on each side; subarticular tubercles strong; inner metatarsal tubercle blunt, elliptical, not very prominent, three fifths length of inner toe; no outer metatarsal tubercle; no tarsal fold. Back with a few scattered small warts, sides and hind limbs with numerous warts; body and limbs with whitish pearl-like excrescences; glandular lateral folds prominent, broken up into warts behind, nearly parallel, the distance between them on the scapular region two ninths length of head and body. Olive-brown above, sides with blackish spots; a blackish temporal spot; tympanum reddish brown; a light streak from below the eye to the angle of the mouth; limbs with dark cross bars; hinder side of thighs marbled with black; throat spotted with brown; belly with a few brown dots.

| | millim. |
|-----------------------------------|---------|
| From snout to vent | 120 |
| Length of head | 37 |
| Width of head | 43 |
| Diameter of eye | 12 |
| Interorbital width | 11 |
| From eye to nostril | 9 |
| " " end of snout | 17 |
| Tympanum | 8 |
| From eye to tympanum | 5 |
| Fore limb | 70 |
| Hind limb | 170 |
| Tibia | 58 |
| Foot | 55 |
| Inner toe | 14 |
| Inner metatarsal tubercle | 8 |

A single female specimen.

This species bears great affinity to *Rana temporaria*, from which the more elongate inner metatarsal tubercle and the prominent rudiment of pollex, which is probably accompanied by an unusual development of copulatory excrescences in the male, easily distinguish it. In size it equals the largest form of the group, *R. Draytoni*, B. & G.

Tylototriton Andersoni, sp. n.

Palatine series of teeth originating a little in front of the choanæ, close together and parallel in front, then slightly diverging, parallel again in the middle, strongly diverging behind. Tongue oval, free on the sides and slightly behind, rather large, its width half that of the mouth. Head as broad as long; snout obtusely acuminate, the lateral outline of the head subtriangular; a rather feeble obtuse ridge along the canthus rostralis and the fronto-squamosal arch; eye moderate; no labial lobes; a short but very prominent parotoid gland. Body twice and a half length of head, much depressed, closely covered with prominent warts of unequal size; vertebral ridge prominent; a series of 14 knob-like glands on each side, the tenth above the hind limb; some of these warts pierced by the extremity of the rib, as in *Molge* (*Pleurodeles*) *Walthii*. A transverse gular fold. Limbs moderate; fingers and toes very short, depressed; fifth toe shortest, almost rudimentary; the hind limb stretched forwards reaches the elbow of the adpressed fore limb. Tail sharp-edged above and below, but without distinct crests, ending in an obtuse point; its length exceeding that of head and body. Black above and below; palms and soles and lower edge of tail orange.

| | millim. |
|----------------------------|---------|
| Total length | 144 |
| From snout to cloaca | 67 |
| Head | 19 |
| Width of head | 19 |
| Fore limb | 24 |
| Hind limb | 25 |
| Tail | 77 |

A single specimen, which I suppose to be a female.

This species is named after Dr. J. Anderson, to whom science is indebted for the discovery of the remarkable newt on which he established the genus *Tylototriton* in 1871. It is easily distinguished from *T. verrucosus* in the triangular instead of semielliptical outline of the head, the less developed cranial ridge, the larger tongue, the shorter digits, and the rudimentary condition of the fifth toe.

XXXVII.—On the Larva of *Molge* Montandoni.

By G. A. BOULENGER.

MOLGE MONTANDONI is one of the few European newts the larva of which is still undescribed. Having been favoured this spring, by Professor von Mähely, with living examples

from Transylvania, I entrusted a few pairs to the care of Mr. S. Ling, in the Natural-History Museum, who succeeded in rearing some twenty larvæ, from which I am able to draw up the following description as a supplement to Dr. von Bedriaga's valuable contribution in the 'Zoologischer Anzeiger' for 1891.

M. Montandoni is more nearly allied to *M. palmata* than to any other species, but it is not without a certain superficial resemblance to *M. alpestris*, especially the female. The larva, however, resembles more that of *M. alpestris* than *M. palmata* in its physiognomy as well as in technical characters; but it differs from both species in their normal condition in having the contour of the tail more obtuse, as in *Salamandra maculosa*.



Larva of *Molge Montandoni*.

Habit short and stout, the distance between fore and hind limbs not twice the width of the head. Eye moderate, its diameter equalling or very slightly exceeding its distance from the nostril, which equals the internarial width; upper eyelid about half as wide as interorbital space, which is a little greater than internarial space. Digits not mucronate. Dorsal crest well developed, originating between the gills. Ten or eleven costal grooves between axilla and groin. Tail measuring less than half the total length, twice and a half to three times as long as deep, its terminal outline rounded or very obtusely pointed. Upper parts, including the gills, very dark, almost black, through crowding of the black dots; a series of small, round, yellowish spots along the lateral line; tail closely and uniformly spotted with blackish; belly transparent, rosy, spotless; iris golden, more or less obscured by blackish dots.

Total length 27 millim.; from end of snout to anus 14; length of head 5; width of head 4; from axilla to groin 7; depth of tail 4.

The larva is figured above, twice natural size.

XXXVIII.—*Liphistius* and its bearing upon the Classification of Spiders. By R. I. POCKOCK.

THE characters of the rare genus *Liphistius*, which is known only from a few specimens, one of which is preserved in the British Museum, have been more or less completely set forth in the writings of Schiödte, Cambridge, and Van Hasselt. From time to time, moreover, Dr. Thorell has given us his views on the affinities of the genus and the importance of its peculiarities, his final decision being that it should constitute a distinct tribe of the Tetrapneumones, equal in value to the Territelariæ, the latter group being the tribe to which he had previously referred it. This classification places *Liphistius* on a higher pedestal than it has occupied before; but, as a result of an examination of the Museum example, the conviction has forced itself upon me that even now the significance of its structural features has been immensely underrated and the homologies of some of its characters not properly understood. No excuse therefore need be sought for briefly recapitulating the most important points of its organization.

Fig. 1.

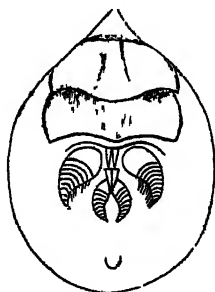


Fig. 2.



Fig. 1.—*Liphistius desutor*. Lower surface of abdomen, to show the eight spinning-mammillæ and the two sternites.

Fig. 2.—*Filistata*, sp. Spinning-mammillæ, showing the form and position of the *cribellum*.

There are two pairs of spinning-mammillæ, an anterior and a posterior, situated near the middle of the lower surface of the abdomen, immediately behind the posterior pair of lung-sacs. The anterior mammillæ are considerably larger than the posterior, but otherwise scarcely differ from them in structure. Each may be described as consisting of two segments, the distal of which is itself composed of a series of annular sclerites. Between these principal mammillæ there are

two smaller auxiliary pairs, an anterior and a posterior, each corresponding to one of the larger mammillæ, and differing from it in consisting of a single, straight, subcylindrical segment, the principal mammillæ being broad at the base, pointed distally, and crescentically curved. Thus there are in all no less than eight mammillæ constituting the external spinning-apparatus, although the two internal pairs appear to be functionless so far as the emission of silk is concerned (fig. 1).

The upper surface of the abdomen is provided with nine * chitinous tergites, the anterior of which are large and overlapping, the posterior small and widely separated. The anterior two are represented on the ventral surface by two large sternal plates, the anterior of which covers the aperture of the generative organs and those of the front pair of pulmonary sacs, the posterior similarly covering the hinder pulmonary sacs.

The cephalothoracic sternum is extremely narrow, its width being about one third of its length; the carapace, on the other hand, is remarkably wide and flat and the coxæ of the ambulatory appendages, compensating for the narrowness of the sternum, are very long. In the British Museum example, moreover, the labium is very short and wide, much wider in fact than the sternum, its great width being due to the prolongation of its lateral borders beneath the coxæ of the second pair of appendages, so that these segments (the maxillæ) are *in front* of the labium, as in *Hypochilus*.

The basal segments of the mandibles are directed forwards, as in the Territelariæ, the plane of their articulation with the cephalothorax being vertical or nearly so with respect to the long axis of the body; but their inner surfaces are not flattened and contiguous to the same extent as in the Territelariæ, their distal extremities diverging so that there is a considerable interval between the bases of the fangs; these fangs consequently when closed lie obliquely inwards and backwards, and not directly backwards as in the Territelariæ.

In the presence of chitinous plates on the upper surface of the abdomen and of two sternal plates on the anterior extremity of its under surface, in the extreme narrowness of the sternum, but above all in the position and structure of its spinning-mammillæ, *Liphistius* differs from all known spiders; and no gradational forms are known which would lessen the

* *Teste* Schiödte. In the British Museum example the integument at the posterior end of the upper surface of the abdomen has been destroyed, so that of my own knowledge I cannot speak as to the exact number of these plates. Seven, however, are clearly visible.

value of these peculiarities. Therefore the structural interval between *Liphistius* and the Theraphosidæ, which have been looked upon as its nearest allies, is greater than the interval between the Theraphosidæ and the Epeiridæ, two families which, omitting *Liphistius*, lie at opposite poles of the order Aranæ. For striking and important as are the differences between *Theraphosa* and *Epeira*, so many intermediate genera are known that it is almost impossible to give any one character that will serve infallibly to distinguish the two sub-orders of Aranæ of which these two genera are types.

The isolated position that *Liphistius* occupies with respect to other spiders can perhaps be best expressed by setting it apart by itself in a group equal in value to a group containing all the others. For these I propose the names Mesothelæ and Opisthothelæ, the terms being derived from the position of the spinning-organs.

This removal of *Liphistius* from the vicinity of the Terretariæ is further supported by the fact that it shows more than one hitherto, I believe, unnoticed point of resemblance to the Dipneumonous spiders. One of these points is the direction of closure of the mandibular fang; the other, which will require some elucidation, is to be found in the structure of the spinning-mammillæ.

In *Liphistius* it will be remembered there are four large and four small mammillæ, the smaller being placed in pairs between and a little in front of the larger. In the Dipneumones there are two large and one small pair of mammillæ, the small pair being placed between and a little in front of the mammillæ of the posterior large pair. There can be no doubt that the larger pairs of mammillæ are strictly homologous in the two types just considered. Moreover I can see no reasonable grounds for doubting that the intermediate pair of the Dipneumones is also homologous to the posterior auxiliary pair of *Liphistius*. This leaves the anterior auxiliary pair of the latter animal to be accounted for. Now in a few families of Dipneumones there is an additional spinning-organ situated in front of the anterior mammillæ and known as the *cribellum*. This usually has the form of a transversely elongated plate; but in *Eristata* it might be described as a large tubercle placed between the anterior mammillæ, the summit of which is divided by a longitudinal groove into a right and left half (fig. 2). This *cribellum*, I believe, is the homologue of the anterior auxiliary mammillæ of *Liphistius* joined together in the middle line. The double origin of the plate is shown by a groove that marks the surface upon which the spinning-tubules are situated. It

has been suggested* that the anterior auxiliary mammillæ of *Liphistius* correspond morphologically to an unpaired process called the *colulus*, which is found between the anterior mammillæ of many spiders, e. g. *Epeira*. If the *colulus* is not found in any spiders that possess the *cribellum*, it seems to me probable that Dr. Thorell's suggestion is correct. But if the *cribellum* and *colulus* coexist in any spider, it is clear that either my suggestion or Thorell's is erroneous.

If the homologies that I have suggested above are correct, some of the Dipneumones at least possess representatives of all the eight mammillæ of *Liphistius*; but this is not the case with any of the Territelariæ. In this group the spinners are nearly always arranged in two pairs—an anterior, consisting of two short one-jointed segments, and a posterior, consisting of two long three-jointed segments. How these mammillæ are to be correctly compared with those of *Liphistius* or of the Dipneumones is to me by no means clear. The posterior pair may be homologous to either of the principal pairs of *Liphistius* and the anterior pair to either of the auxiliary pairs of this animal; or the two pairs may correspond to the two principal pairs of *Liphistius*. But in either case the disappearance of two pairs has to be accounted for. Some of the Territelariæ, however, such as *Pelecodon* and *Hexathele*, have six mammillæ, the additional ones being short and placed in a transverse line with the ordinary anterior pair. But the anterior series is not alike in the two genera, the two internal mammillæ being considerably larger than the two external in *Pelecodon*, the converse obtaining in *Hexathele*. This renders a comparison between them a matter of some difficulty. I venture, however, to make the following suggestions on the point. In *Pelecodon* the large internal pair is homologous to the anterior pair of the Dipneumones and of the anterior principal pair in *Liphistius*, the smaller external pair being the homologues of the intermediate pair of the Dipneumones and of the posterior auxiliary pair of *Liphistius*. If this be so, the last-named mammillæ have shifted their position so as to lie completely in front of the posterior mammillæ. As regards *Hexathele*, it seems reasonable to suppose that the mammillæ that are present are the same as those that are developed in *Pelecodon*. They may, too, correspond exactly in position although differing in size. An alternative hypothesis, however, is that the large pair of this anterior series in *Hexathele* corresponds to the large ones in *Pelecodon*. In this case the small intermediate pair in

* Vide Thorell, Ann. Mus. Genov. xxviii. p. 29 (1889-90).

Hexathele have moved forwards internally and not externally. This question, however, presents many difficulties in the way of its solution, and requires far more attention than I have so far been able to bestow upon it. Enough, however, has, I think, been said to show that, so far as the spinning-organs are concerned, *Liphistius* seems to approach the *Dipneumones* more nearly than the *Territelariæ*.

If this view as to the correspondence between the *cribellum* and the anterior auxiliary mammillæ of *Liphistius* is correct, it has I think an important bearing on the classification of spiders.

In 1886 Dr. Thorell * gave a concise sketch of the views of his predecessors and contemporaries on the subject of the classification of the *Aranæ*. The object of this paper was the refutation of the system proposed by that eminent entomologist Dr. Bertkau; and at the end of his criticisms Dr. Thorell put forward a classification of his own, introducing sundry changes into that which he had previously used, in accordance with the greater value that was attached by Bertkau to certain structural features that Thorell had previously looked upon as of secondary importance.

In this new system the old divisions of spiders into *Tetrapneumones* and *Dipneumones* is adopted. For subdivisions of the *Dipneumones* the old tribal names *Tubitelariæ*, *Orbitelariæ*, *Citigradæ*, &c. are retained, the two former being subdivided into *Cribellatæ* and *Ecribellatæ*, according as the *cribellum* (and *calamistrum*) are present or not. The *Tetrapneumones* contain the single tribe *Territelariæ*, embracing the families *Liphistiidæ*, *Theraphosidæ*, and *Atypidæ*.

In its main characters this classification has been adopted by Dr. Marx †, in his 'Catalogue of North-American Spiders.' One modification, however, is the introduction into the *Tetrapneumones* of the remarkable genus *Hypochilus*, for which a new tribe, *Umbellitelariæ*, is established. Moreover, Dr. Marx appears not to attach so much importance as Dr. Thorell to the presence of the *cribellum* and *calamistrum*. Furthermore he adopts Dahl's tribe *Plagitelariæ* for the *Pholcidæ*, and creates a new tribe, *Filitelariæ*, for the *Dysderidæ*, *Filistatidæ*, and *Scytodidæ*.

In 1891 Dr. Thorell ‡ favoured us with fresh views on the subject. He forms a new tribe of *Tetrapneumones*, named *Verticulatæ*, for *Liphistius*, and retains *Hypochilus*

* Ann. & Mag. Nat. Hist. (5) xvii. pp. 301-326.

† Proc. U. S. Nat. Mus. xii. p. 498 (1889).

‡ Kongl. Sv. Vet.-Akad. Handl. xxiv. no. 2, pp. 8, 9.

where it was placed by Marx. In the Dipneumones he establishes a second new tribe, Pseudoterritelariæ, for the Dysderidæ, and a third, Cavitelariæ, for *Filistata* alone.

In 1890, however, Mons. Simon*, who has probably examined more spiders from all parts of the world than any man living, proposed a classification which differs materially from that of Thorell. In the first place he divides the order into two suborders, Araneæ Theraphosæ and Araneæ veræ, the former to comprise the Liphistiidæ and Aviculariidæ, the latter the Dipneumones + *Hypo-chilus*. The abandonment of the old names Tetrapneumones and Dipneumones is enforced by the removal of *Hypo-chilus*, which has four lung-sacs, from the vicinity of the Aviculariidæ to that of the tracheate spiders.

This author further subdivides his Araneæ veræ into Cribellatæ and Ecribellatæ, for those with and those without the *cribellum*, and does not follow Dr. Thorell in the adoption of the tribal groups Orbitelariæ, Tubitelariæ, &c.

The classification that I venture here to put forward is new so far as the position of *Liphistius* is concerned, and for the rest is a combination of the systems that have briefly been discussed.

As stated above, it seems to me that the value of the characters of *Liphistius* have been immensely underrated. I consequently propose to divide the Araneæ into Mesothelæ and Opisthothelæ, the first for *Liphistius*, the second for the rest. As regards the subdivision of the Opisthothelæ, I am entirely in accord with Mons. Simon and Dr. Bertkau that *Hypo-chilus* should not be associated with the Theraphosidæ, being more nearly related to the Dipneumones, in spite of its four lung-sacs. This view stands in the way of the adoption of the terms Tetrapneumones and Dipneumones; but since the double terminology of Mons. Simon seems to me somewhat cumbersome, I venture to propose as substitutes the names Mygalomorphæ and Arachnomorphæ†. The former suborder will contain at least two families, Atypidæ and Theraphosidæ or Aviculariidæ. The latter will correspond exactly

* Ann. Soc. Ent. Fr. 1890, pp. 79-82.

† I use the name Mygalomorphæ because the spiders of this group are still spoken of collectively by the uninitiated as *Mygale*; and this name has been introduced into nearly all text-books of zoology and into very many popular and semipopular works on natural history to designate the large hairy Territelariæ, which are so familiar to every one. Similarly the name Arachnomorphæ seems applicable to a group of spiders which embraces all the common house and field species, these being doubtless the kinds that the Greeks spoke of comprehensively as ἀράχνης or ἀράχνη.

to Thorell's *Dipneumones* + *Hypochilus*, and it may accordingly be divided into *Umbellitelariæ*, *Cavitelariæ*, *Pseudoterritelariæ*, *Tubitelariæ*, &c. I am inclined, however, at present to follow Dr. Marx in considering that the peculiarities of the *Pholciæ* are sufficient to justify Dahl in the establishment of a special tribe, *Plagitelariæ*, for the reception of this family. Furthermore I do not consider that the presence of the *cribellum* and *calamistrum* is necessarily an indication of affinity between two or more families, even when they belong to the same tribe. I even doubt if the presence of these organs is sufficiently important to form a basis upon which to establish families, and therefore *à fortiori* I cannot agree with Mons. Simon in dividing the *Arachnomorphæ* into *Cribellateæ* and *Ecribellateæ*.

This view as to the value of the *cribellum*, however, requires some justification in the face of the great importance that is attached to it by such eminent arachnologists as Mons. Simon and Dr. Bertkau.

It must be admitted on all hands that the value of this character depends upon our knowledge of its origin. The *cribellum* and *calamistrum* are found in certain families which differ widely in other respects in structure and habits. Its presence in these families may be accounted for, firstly, on the hypothesis that they represent a natural group which has evolved itself in a line parallel to the *ecribellate* spiders, the two groups independently acquiring a similarity in form and instincts; secondly, on the hypothesis that the *cribellum* has been independently developed in many of the families that possess it; thirdly, on the hypothesis that the ancestor of existing spiders was *cribellate*, and that only a few of the families in the course of their evolution have retained the organs in question.

The second of these possible explanations seems extremely improbable, and is adopted by no one, so far as I am aware. The classifications, however, of Bertkau and Simon imply a belief in the first. Thorell, on the contrary, accepts the last, although he has not produced a large stock of evidence to support it. Nevertheless that he is right in his opinion I do not doubt, although at the same time I fear that our views are diametrically opposed on the subject of the ancestry of spiders. He does not believe in the descent of these animals from forms allied to the *Pedipalpi*, and he considers that the resemblances between *Liphistius* and *Phrynus* are merely analogous. I, on the contrary, think that there is a mass of evidence, based upon anatomical and embryological grounds, pointing to the conclusion that the *Aranææ* are the descen-

dants of the Pedipalpi and the latter of the Scorpions; or, to put it differently, that of existing Arachnida the Pedipalpi come nearest to the immediate ancestors of spiders and the Scorpions nearest the ancestors of the Pedipalpi. I hope in a subsequent paper to work out the classification of Arachnida from this standpoint. At present it will be sufficient to state that the primitive nature of the structure of Scorpions is shown by the metamerism of the body, the serial repetition of similar somites being carried to a greater extreme than in any other order of Arachnida.

This then being my belief as to the ancestry of the Araneæ, I see no escape from the conclusion that *Liphistius* is a transitional form—a missing link—between the Opisthothelæ and the Phrynidæ. Certain it is that *Liphistius* possesses at least two important permanent characters which are only found in the embryos of other spiders. These characters are the segmentation of the abdomen and the anterior position of the external spinning-organs. As is well known, these organs are the third and fourth pairs of abdominal appendages, which are primitively situated in a line with the first and second pairs on the lower surface of the anterior half of the abdomen. The migration of these appendages to the posterior end of the body, which takes place in all spiders except *Liphistius*, is a secondary modification which is no doubt beneficial as conferring a greater freedom and range of movement upon organs requiring considerable manipulation.

Liphistius, then, retains certain embryonic characters that all other spiders lose; we may conclude therefore that the latter are “higher” than the former. Of the other spiders, those that on the whole come nearest to *Liphistius* are the Mygalomorphæ. These therefore are “lower” than the Arachnomorphæ; and the lowest of the Arachnomorphæ are *Hypochilus*, *Dysdera*, and *Filistata*.

Since, then, some reasons have been shown for thinking that *Liphistius* is of living spiders the nearest to the ancestral form, and, secondly, that this spider possesses the homologue of the *cribellum*, we can without difficulty explain the existence of this organ in widely different genera, and its presence at once loses the systematic importance that Dr. Bertkau and Mons. Simon have claimed for it.

The same argument will apply to the presence of two or three claws on the feet of the Opisthothelæ; for since *Liphistius* possesses three well-developed claws, the third claw may have been retained or lost indiscriminately, so to speak, in different genera. So that Bertkau's subdivisions of Ecri-

bellata into Artionycha and Perissonycha and Ausserer's subdivisions of Theraphosidæ into Dionycha and Trionycha may not represent natural groups.

The principal divisions of the Araneæ that I here propose may be diagnosed as follows:—

- a. The spinning-appendages retain their embryonic position in the middle of the lower surface of the abdomen; there are eight spinning-mammillæ. The upper surface of the abdomen is furnished with nine distinct tergites and the lower with two distinct sternites. The cephalothoracic sternum is extremely narrow as compared with the width of the carapace **Mesothelæ.**
Fam. *Liphistiidæ*.
- b. The spinning-appendages migrate to the posterior end of the abdomen; there are never more than six distinct mammillæ. The abdomen is never provided with distinct tergal plates, and the abdominal sternites persist only as the pulmonary opercula and ? the epigyne. The cephalothoracic sternum is much wider as compared with the carapace **Opisthothelæ.**
- a'. The plane of the joint of the mandible with the cephalothorax is nearly vertical, the fang closing almost directly backwards. Four lung-sacs, the posterior widely separated, close behind the anterior, and with distinct opercula. Usually only four, rarely six spinning-mammillæ **MYGALOMORPHÆ.**
Fam. *Aviculariidæ*, *Atypidæ*.
- b'. The plane of the joint of the mandible with the cephalothorax nearly horizontal, the fang closing obliquely inwards and backwards. The posterior lung-sacs almost always replaced by tracheal tubes; when retained, as in *Hypochilus*, they are situated in the middle of the abdomen and covered with a continuous fold of the integument. With six spinning-mammillæ; not uncommonly the fourth pair found in *Liphistius* is retained as the *cribellum* **ARACHNOMORPHÆ.**
Fam. *Hypochilidæ*, *Dysderidæ*,
Filistatidæ, *Drassidæ*, &c.

XXXIX.—Revision of the Noctuid Genus *Melipotis*, Hübn., with Descriptions of Two new Species. By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE genus *Melipotis* (*Bolina*, Guen., and *Leucanitis*, auct.) has been wrongly made the type of a separate family—*Bolinidae*—by Guénée. As a matter of fact it is closely allied to the Old-World genus *Ercheia* (confounded by some authors with *Melipotis*, Hübn.), and varies precisely in a similar manner.

The earlier authors imagined that the variation which exists in the species of *Melipotis*, and more particularly in individuals of the female sex, represented permanent and distinct types; but a careful examination of a series obtained from any one locality soon demonstrates the fact that, whereas there is little variation in the pattern of the posterior wings and the under surface of all the wings, the variation of the upper surface of the anterior wings is often quite remarkable and has led to the needless multiplication of species.

Since taking up the study of the genus I have come across a paper on West-Indian species of *Melipotis* by the late Dr. Moeschler, in which he shows that he evidently arrived at much the same conclusion as I have done. Unfortunately his material was inferior to that of the Museum collection. Though I could wish that we had finer series of some of the species, there are very few forms of which we do not possess representatives, or, at any rate, examples of nearly allied types. I have therefore come to the conclusion that it will be advantageous to students to publish the result of my study of our material.

Melipotis cailino.

Ophiusa cailino, Lefebvre, Ann. Soc. Linn. Paris, vi. p. 96, pl. v.

Asia Minor, Caucasus, Schuscha. In B. M.

Our three examples of this species show very little variation; but a large series would probably exhibit the usual variability of the genus.

Melipotis inepta.

♀. *Thria*? *inepta*, Butler, P. Z. S. 1881, p. 620.

Chaman, S. Afghanistan. Type B. M.

I think it possible that this may be the female of *M. flexuosa*; but the borders of the primaries below are broadly white,

with a black apical spot, whereas in *M. flexuosa* they are brown with a white subapical costal spot. As such differences do not occur in other species of the genus, it is better to keep the two types separate until a series can be examined; the figure of *M. flexuosa* agrees with our example of it.

Melipotis flexuosa.

Ophiura flexuosa, Ménétriés, Mém. Acad. Imp. St. Pétersb. vol. vi. p. 292, pl. vi. fig. 5 (1848).

"Abscheron." B. M.

Whether the word on the label is a locality or not, I have not been able to discover. Staudinger gives the localities "Shores of the Caspian, Syria, Southern Pontus, and S.E. Kirghis."

Melipotis picta.

Leucanitis picta, Staudinger, Stett. ent. Zeit. xxxviii. p. 192 (1877).

Krasnow. B. M.

We have three examples exhibiting no great variation; that the species does vary in the usual way is, however, proved by the note in Romanoff (Mém. vol. iii. p. 91):—"Among the many examples from Askhabad two females are remarkable for their unusual size and dark hind wings; the spots are, however, not, as usual, white, but brownish."

It has been asserted that *Leucanitis* and *Melipotis* are synonymous, and as *L. rada* seems undoubtedly to be a *Melipotis*, this is correct; but all the species placed by Dr. Staudinger under *Leucanitis* are not congeneric: *L. cestis* and *Palpangula Henkei* differ entirely from *Melipotis* in their palpal structure and may both be placed under *Palpangula*.

Melipotis ochrodes.

♂. *Bolina ochrodes*, Guenée, Noct. iii. p. 64. n. 1400 (1852).

♀. *Bolina heliothoides*, Guenée, l. c. p. 68. n. 1410 (1852).

♂ ♀. *Bolina terminifera*, Walker, Lep. Het. xiii. p. 1151. n. 16 (1857).

♂. *Melipotis nigrescens*, Grote (see Check-List, p. 39. n. 1144).

Venezuela, St. Domingo, Jamaica, Texas. In B. M.

Var. *manipularis.*

♀. *Bolina manipularis*, Guenée, Noct. iii. p. 68. n. 1409 (1852).

Bolina indomita, Walker, Lep. Het. xiii. p. 1161. n. 33 (1857).

♂. *Melipotis ochreipennis*, Harvey (see Grote, Check-List, p. 39. n. 1145).

♂ ♀, Brazil and Kansas. In B. M.

Variable as this species is there is a wonderful uniformity of pattern, with dissimilarity of colouring, in the primaries of all our specimens, even the little oblique white line across the end of the discoidal cell being invariably present. It is unfortunate that the name *ochrodes* should be the oldest, as it represents a varietal form of the male of which *M. ochreipennis* is only a larger and slightly darker sport; the central belt in this form is more or less ochreous and the base of the wing is very dark. Guenée's *B. heliothoides* was based upon a female in which the primaries were almost uniformly ashy grey, the markings being indistinct; we have females of this type from Venezuela and St. Domingo and a series of males forming a transition from it to Walker's *B. terminifera*, which is identical with Grote's *M. nigrescens*. The form separated as var. *manipularis* is composed of rather large specimens, the secondaries of which tend more or less to become dusky; but the distinction is purely an arbitrary one, and the specific identity of *M. manipularis* with *M. ochrodes* is undoubted.

Melipotis pallescens.

Melipotis pallescens, Grote and Robinson (see Check-List, p. 39. n. 1146).

United States. In B. M.

This species is allied to *M. ochrodes*, but differs chiefly in the angular outer edge to the basal area of primaries and the very narrow border to secondaries. It appears to be a good distinct species. One example (not the type) was in the Grote collection. The narrow border to secondaries alone would not suffice to distinguish this species, as some examples of *M. ochrodes* vary considerably in this respect.

Walker has greatly complicated the identification of *M. Guenée's* species by placing specimens under his names which do not correspond at all with his descriptions, and redescribing them as var. ? in each case; of course the true species of the French author are redescribed as new forms.

Melipotis marmoraris.

Bolina marmoraris, Guenée, Noct. iii. p. 67. n. 1407 (1852).

Bolina fanelica, Walker (not Guenée), Lep. Het. xiii. p. 1146. n. 6 (1857).

Bolina januaris, Walker (not Guenée), l. c. p. 1149. n. 9 (1857).

Bolina glaucipennis, Walker, l. c. p. 1153. n. 19 (1857).

Bolina disturbans, Walker, l. c. p. 1162. n. 35 (1857).

Achæa indistincta, Butler, P. Z. S. 1878, p. 488. n. 100.

Venezuela, Honduras, St. Domingo, Jamaica. In B. M.

Var. stolidæ.

Bolina stolidæ, Walker, Lep. Het. xiii. p. 1162. n. 34 (1857).

Bolina excepta, Walker, l. c. p. 1165. n. 40 (1857).

Melipotis stygialis, Grote (on type label).

Venezuela, Honduras, and United States. In B. M.

The whole of these specimens correspond in the position of the markings on the primaries, even to the little white transverse marking on the discocellulars, although they, as usual, show considerable variation in ground-colour; they also agree in the pattern of the secondaries and under surface, and therefore I have not the slightest hesitation in pronouncing them slight variations of one species.

With regard to *Melipotis stygialis*, two specimens so labelled were in the Grote collection, one of them marked "type," and as they are not included under *Melipotis* in the 'Check-List' of 1882, I can only suppose that they were subsequently described; they are simply larger specimens of the insect from Venezuela to which Walker gave the name *Bolina excepta*.

Melipotis perpendicularis.

Bolina perpendicularis, Guenée, Noct. iii. p. 65. n. 1404 (1852).

Var. *Bolina limitata*, Moeschler, Abh. senck. Ges. xiv. p. 55, pl. — fig. 16 (1886).

Venezuela, Honduras, and Jamaica. In B. M.

Our examples of this species show very little variation; it is allied to *M. marmoraris*. Moeschler figured a slight variety.

Melipotis januaris.

Bolina januaris, Guenée, Noct. iii. p. 67. n. 1406 (1852).

Bolina russaris, Guenée, l. c. p. 69. n. 1411 (1852).

Bolina excavans, Walker, Lep. Het. xiii. p. 1154. n. 21 (1857).

Bolina subtilis, Walker, l. c. p. 1156. n. 24 (1857).

St. Domingo. In B. M.

B. excavans is typical *M. januaris* and *B. subtilis* is an intermediate form linking it to *B. russaris*; all the forms are identical on the under surface, which is rather peculiar and not likely to be confounded with that of any other species; the upper surface of the secondaries also shows no variation and that of the primaries corresponds as regards the defined markings, although in *B. russaris* they are barely indicated.

Melipotis surinamensis.

♂. *Bolina surinamensis*, Moeschler, "Beitr. Schmett. Surin.," in Verhandl. zool.-botan. Gesellsch. Wien, 1876, p. 416. n. 65.

♀ (as ♂). *Bolina sphaerita*, Moeschler, l. c. p. 417. n. 66, pl. viii. fig. 4 (1876).

Surinam. ♂, "Ecu." (Ecuador?). In B. M.

I have no doubt that Moeschler has wrongly sexed his female; the style of coloration given occurs in no male *Melipotis* that I have ever seen, but corresponds closely with the red form of female of *M. januaris*. The description of the male corresponds pretty closely with our solitary male, which nearly resembles *M. januaris* ♂ on the upper surface, though widely differing below.

Melipotis bisinuata.

Bolina bisinuata, Felder, Reise der Nov., Lep. iv. pl. cxii. fig. 19.

Goya, Argentine Republic (*Perrins*). In B. M.

Allied to *M. cellaris*, but readily distinguishable by the pale brownish-buff secondaries with dusky veins, blackish at base of median branches, and by the paler basicostal area of primaries and form of the whitish transverse band, which barely interrupts that area; the black triangular patch on inner margin towards the base also has an angular outer edge.

Melipotis cellaris.

Bolina cellaris, Guenée, Noct. iii. p. 66. n. 1405 (1852).

Bolina turbata, Walker, Lep. Het. xiii. p. 1160. n. 32 (1857).

Panula insipida, Felder, Reise der Nov., Lep. iv. pl. cxii. fig. 16.

Panula inconstans, Grote (not Guenée), Check-List, p. 39. n. 1114.

Venezuela and Texas. In B. M.

As we only have three examples of this species there is not much scope for variation.

Melipotis parens.

Bolina parens, Walker, Lep. Het. xiii. p. 1154. n. 20 (1852).

St. Domingo. Type in B. M.

A single example only; it has characters in common with *M. januaris*, but the pattern of the under surface differs so much that without intermediate forms it is impossible to regard it as a variety of that species.

*Melipotis famelica.**Bolina famelica*, Guenée, Noct. iii. p. 62. n. 1306 (1852).*Bolina bivittata*, Walker, Lep. Het. xiii. p. 1156. n. 23 (1857).

St. Domingo, St. Vincent, Jamaica, Honduras, Venezuela.
In B. M

*Melipotis imparallela.**Bolina imparallela*, Guenée, Noct. iii. p. 65. n. 1402 (1852).Var. ? *Melipotis nigrobasis*, Guenée, l. c. n. 1403 (1852).

Colombia, Mexico.

The description of the primaries in this species seems to indicate affinity to *M. cellaris*, but the secondaries seem to bring it nearer to *M. famelica*. Mr. Druce's figure (Biol. Centr.-Am. tab. xxxi. fig. 13), from the type forwarded by M. Oberthür, does not correspond with the description by M. Guenée, but agrees pretty closely with the male of *M. fasciolaris*, var. *cunearis*, Guen. According to that author his type is 41 millim. in expanse (3 more than in the figure), "the upper wings are of a dark grey-brown, slightly violaceous, with the basal area clearer, flesh-tinted, cut obliquely and traversed by several fine, indistinct, parallel, approximated grey lines. A straight central band, oblique in the opposite direction, of the same colour as the base, and divided also by three fine reddish threads, against the last of which the extracellular patch is attached, oval, oblong, or often reniform and broader than the band, of a clear yellowish-flesh tint. Between the two bands the area is varied with black, and beyond the latter the black forms little spines." So far the description differs in almost every particular from the species figured as Guenée's type, and therefore I can only suppose that, since the publication of the third volume of the 'Noctuérites,' the type-label has been accidentally transferred to the wrong species. Until I had made up my mind respecting the synonymy of the species in this genus, I refrained from looking to see what Mr. Druce had done with regard to it; therefore I am agreeably surprised to find that where he has put species together he has, in almost every instance, come to the same conclusion as I have. He has, it is true, not gone so far as I have done, and in the case of *M. famelica* he has adopted Walker's identification (which is certainly incorrect, as the description shows); but in the main we are agreed.

*Melipotis novanda.**Bolina novanda*, Guenée, Noct. iii. p. 64. n. 1399 (1852).*Bolina luciopera*?, Walker, Lep. Het. xiii. p. 1152. n. 17 (1857).

St. Domingo. In B. M.

I do not feel quite certain of this identification, but Walker's species answers pretty closely to *M. Guenée's* description. Walker's identification was utterly erroneous, the example from Jamaica being *M. famelica*.

*Melipotis evelina.**Bolina evelina*, Butler, P. Z. S. 1878, p. 487. n. 94.

Jamaica. Type in B. M.

Allied to the preceding species, but, I think, distinct, the postdiscoïdal spot being externally bidentate instead of tridentate.

*Melipotis strigifera.**Bolina strigifera*, Walker, Lep. Het. xiii. p. 1153. n. 18 (1852).

St. Domingo. Type in B. M.

This species differs from the following in the undentated character of the postdiscoïdal spot of primaries.

*Melipotis contorta.**Bolina contorta*, Guenée, Noct. iii. p. 64. n. 1401 (1852).*Bolina bistriga*, Walker, Lep. Het. xiii. p. 1155. n. 22 (1857).*Bolina striolaris*, Herrich-Schäffer, Corr.-Blatt zool. min. Ver. Regensb. 1868, p. 186.

St. Domingo. In B. M.

*Melipotis comprehendens.**Bolina comprehendens*, Walker, Lep. Het. xiii. p. 1163. n. 37 (1852).

Brazil. Type in B. M.

This species is intermediate in character between *M. contorta* and *M. prolata*; it is of the same size as the former, with a similarly bidentated postdiscoïdal spot on primaries; but in the obscure character of its markings, in the pattern of the secondaries and of the under surface, it more nearly approaches the latter.

*Melipotis prolata.**Gerespa prolata*, Walker, Lep. Het. xiii. p. 1169. n. 1 (1857).

Jamaica. Type in B. M.

If the type of *Melipotis* should be considered generically distinct from the bulk of the species on account of the fan-shaped brush of hairs on the middle legs of the male, most of the other species would have to be referred to *Gerespa*, of which this is the type; I believe, however, that the apparent absence of the brush in most males is simply due to the fact of its being concealed in its sheath, for one male of *M. famelica* in our series shows a few isolated hairs, and a male of *M. fasciolaris* shows a brush on one side only.

Melipotis gubernata.

Bolina gubernata, Walker, Lep. Het. xiii. p. 1163. n. 36 (1852).

Bolina decreta, Walker, Lep. Het. xiii. p. 1164. n. 39 (1852).

Pará and Honduras. Type in B. M.

Closely allied to *M. prolata*, but with the basal half of the secondaries above and the basal two thirds of the primaries below white; the white postdiscoïdal spot on the under surface of the latter wings is also larger.

Melipotis fasciolaris.

♂. *Ædia fasciolaris*, Hübner, Exot. Schmett. Zutr. figs. 443, 444.

♀. *Bolina limitaris*, Guenée, Noct. iii. p. 70. n. 1413 (1852).

Bolina cunearis, Guenée, l. c. n. 1414 (1852).

Bolina fuscaris, Guenée, l. c. n. 1415 (1852).

♂. *Bolina illuminans*, Walker, Lep. Het. xiii. p. 1164. n. 38 (1857).

United States, Veragua, Trinidad, Honduras, Venezuela, St. Domingo, Rio Jurua, Tapajos, São Paulo, Lake Iguarazu. In B. M.

The male varies very little, but the female considerably. *B. cunearis*, Guen., in spite of the almost entire obliteration of the postdiscoïdal spot on the upper surface of the primaries, is most like the male in colouring, and *B. fuscaris* is least like; the latter, however, appears to be the commonest form of the female. Guenée's "male" of *B. cunearis* is probably a female. When the frenulum is not examined it is natural to suppose a smaller and more slender-bodied female to be a male.

Melipotis jucunda.

Melipotis jucunda, Hübner, Exot. Schmett. Zutr. figs. 181, 182.

United States. In B. M.

Like the preceding species *M. jucunda* varies more in the female than in the male sex.

Melipotis rada.

Microphisa rada, Boisduval, Ann. Soc. Ent. France, 2^e sér. vi. Bull. xxx. p. 12.

Helenendorf. In B. M.

BULIA, Walker (= *Biula*, Walk.).

This little genus, if distinct from *Melipotis*, is very nearly allied to it. All the examples which I have seen have the third joint of the palpi short and projecting forward from the extremity of the second; the males have very finely ciliated antennæ. Herr Snellen has, however, figured two totally different types of palpi for his *Bolina abrupta*; otherwise I should have supposed them to be mere sports of Guenée's *Bolina brunnearis*, of which the following is the synonymy:—

Bulia brunnearis.

Bolina brunnearis, Guenée, Noct. iii. p. 68. n. 1408 (1852).

Bolina confirmans, Walker, Lep. Het. xiii. p. 1157. n. 25 (1857).

Bolina umbrosa, Walker, l. c. p. 1158. n. 26 (1857).

Bolina recipiens, Walker, l. c. p. 1165. n. 41 (1857).

Biula propria, Walker, l. c. p. 1170. n. 1 (1857).

Arsisaca bolinalis, Walker, l. c. Suppl. iv. p. 1262 (1865).

St. Domingo, Venezuela, and Jamaica. In B. M.

Three of Walker's five types are of the same variety and nearly resemble in pattern Snellen's figure 1 of *B. abrupta*, whereas the two others are of the type represented by his figure 2.

Bulia abrupta.

Bolina abrupta, Snellen, Tijdschr. voor Ent. xxx. p. 44, pl. iv. figs. 1, 1 a, 2, 2 a (1887).

Curaçao.

I fail to see any reason for separating *Cirrhobolina* from *Bulia*; both pattern and structure seem to agree admirably.

Melipotis agrotipennis, Harvey, is *Bolina agrotoides*, Walker, and belongs to the genus *Pandesma*.

Leucanitis tenera, Staudinger (in litt. ?), from Russia, and its variety *L. antiqua* (Stett. ent. Zeit. 1887, p. 56), *L. nana*, and perhaps *Palpangula cestina* and *spilota* (Romanoff's Mém. Léop. i. pl. ix. figs. 6, 7, and 8), probably belong to Walker's genus *Anumeta*; *L. tenera* certainly does, for it not only has almost the same pattern and coloration, but agrees in structure, the third joint of the palpi being very short.

Leucanitis sinuosa, Staudinger, in Romanoff's Mém. vol. i. pl. ix. fig. 5, and *L. Saissani*, in vol. ii. pl. iii. fig. 13, from Helenendorf, seem to be scarcely distinct from *M. flexuosa*, certainly less so than my *M. inepta*.

"*Leucanitis*" *stolida*, Fabr., is a *Grammodes*.

L. obscurata, Staudinger, Romanoff's Mém. vol. v. (1889), is unknown to me.

Melipotis ambidens and *Gundiani*, Felder, Reise der Nov., Lep. iv. pl. cxvi. figs. 9 and 10, are referable to *Ercheia*; and *Leucanitis Schraderi*, Felder, l. c. fig. 7, is *Dysgonia latizona*.

Melipotis strigipennis and *costipannosa* of Moore, Lep. Atk. Coll. (see pl. v. fig. 8), from Darjiling, are both species of *Ercheia*.

Bolina revulsa, Wallengren, Öfvers. Akad. Förhandl. xxxii. p. 116 (1876), from the Transvaal, appears to be somewhat allied to *M. rada*, but may, perhaps, not belong to the genus.

Leucanitis Hedemanni, Staudinger, Stett. ent. Zeit. xlix. p. 257 (1888), to judge by the description, must be a *Dysgonia* allied to *D. algira*. It is from the Amur and China.

Leucanitis aberrans, Staudinger, Stett. ent. Zeit. xlix. p. 49, from Kuldja, is allied to *L. tenera*, and therefore is a species of *Anumeta*. *L. sesquilinea*, l. c. p. 51, from Samarcand, may be my *M. inepta*, in which case, of course, it will fall. At the same time, judging by the variability of other species of *Melipotis*, I am convinced that Staudinger has unnecessarily split up the *M. cailino* group, which may consist of only one variable species.

Snellen's *Bolina* ? *calamioides* seems to me to have little in common with *Melipotis* (see Tijd. voor Ent. xxx. p. 47, pl. iv. figs. 3, 3a, 1887); according to the figure it does not even belong to the Quadrifidæ.

Melipotis tenella, H. Edwards, from N.W. Texas (*Papilio*, i. p. 26, 1881), may be a form of the female of *B. fasciolaris*; but, as I have not seen an example compared with the type, I cannot speak with certainty.

Melipotis perlæta, H. Edwards, from Arizona (*Papilio*, ii. p. 14), is also unknown to me; but it is probably only a female variety of *M. ochrodes*.

The description of *Bolina mesoleuca*, Walker, Char. Het. Lep. p. 51 (1869), is utterly unintelligible and probably represents a species of some other family. No locality is recorded.

Bolina agrotidea, Mabille, Ann. Soc. Ent. France, 3^e sér. vol. i. p. 346 (1879), from Madagascar, of course has nothing to do with the genus; but what it is I cannot pretend to say. It is not included in Saalmüller's work published in 1884. Perhaps, in the absence of any positive knowledge of its affinities, this species may be best placed under *Tarasana*, Moore, to which genus *Melipotis sinualis*, Harvey (= *Bolina acontoides*) belongs.

I believe that *Bolina hadeniformis*, Behr, Trans. Am. Ent. Soc. iii. p. 25 (1871), from California, is nothing more than one of the many female varieties of *M. ochrodes*. We have a female from St. Domingo for which the description might have been written. Every form of this variable species seems to have been favoured with a name.

Moeschler considers *Bolina leucomelana*, Herrich-Schäffer, Corr.-Blatt zool.-min. Ver. Regensb. 1868, p. 186, from Cuba, to be allied to *Melipotis contorta*, but distinct; some of the characters by which he distinguishes it are, however, possessed by our examples of *M. contorta*. *B. rectifascia*, H.-Sch. (loc. cit.), appears to me to be *M. perpendicularis*, and according to Moeschler *M. parvicolor* is only a worn example of *M. rectifascia*.

Several species placed by Staudinger in his Catalogue under *Leucanitis* are unknown to me, and may or may not belong to this genus.

Having thus summed up the named species of *Melipotis*, I find that I have two species to name, viz. :—

Melipotis Walkeri, sp. n.

♂. Primaries above with the basal fifth pale greyish brown, bounded externally by a slightly sinuous blackish band, tapering from inner margin to costal vein and followed by a broad clear ochreous belt; the latter twice as wide on inner margin as at its anterior extremity, with convex inner and concave outer margin; this belt is connected (after the manner of that of *M. perpendicularis*) by an oblique grey bar to the reniform spot, which is confluent with the latter, grey enclosing two black dots, margined on the upper half of its inner margin by a curved, transverse, black-edged white

dash, and separated from the greyish testaceous postdiscoidal patch by a slender trisinuated white line; the form of the postdiscoidal patch is like that of *M. perpendicularis*, and (as in that species) a very irregular slender black line runs round its outer edge inwards along the little grey connecting bar and outwards along the edge of the ochreous belt; the small quadrate patch within the cell enclosed between the anterior portion of the ochreous belt and the reniform spot is dull reddish clay-coloured; the irregular interval (tapering from costa) between the postdiscoidal patch and the external area is grey varied towards costa with clay-colour and bounded externally with blackish; the external area itself is formed as in *M. perpendicularis*, is whitish brown clouded externally and obliquely streaked at apex with grey; the fringe is pale buff, traversed by two imperfect wide grey stripes: secondaries with the basiabdominal third greyish white, silvery opaline towards costa, dusky at base of median branches; centre of wing from costa to near anal angle occupied by a semitransparent decreasing white belt, slightly tinted at its extremities and on the centre of the interrupting nervures with buff; apical area and external border deep bronze-brown; the nervures as they pass from the central white belt on to the brown area being blackish, so as to form short streaks; a blackish spot at centre of outer margin, bounded on each side by pale ochreous marginal spots, a third pale ochreous spot at apex; fringe white, more or less tinted with grey-brown opposite to the intervals between the ochreous spots: body grey, decreasing in intensity from the head backwards, the anal tuft being almost white; below whitish. Under surface of wings very similar to that of *M. bisinuata*, but much whiter, and with the brown areas paler and more restricted; the white belt of the secondaries as above (not irregularly curved as in *M. bisinuata*) and with no trace of the black discocellular spot or blackish streaks at the base of the median branches and radial vein.

Expanse of wings 38 millim.

Two examples. Callao (*J. J. Walker*). Type in B. M.

I have named this pretty little species in honour of its indefatigable collector, to whose zeal and patriotism the Museum is indebted for many rare and beautiful new species.

It is rather difficult to decide upon the best position in the genus for *M. Walkeri*, since it combines characters found in *M. ochrodes*, *perpendicularis*, and *bisinuata*; I think perhaps it will stand most naturally next to the last of these three.

Melipotis Yerburyi, sp. n.

♂. Primaries above greyish brown, slightly inclining to olivaceous*; a basi-internal streak or oblique patch, a slightly irregular and curved black-edged belt from costa to inner margin before the middle, the postdiscoidal patch and a transverse subapical costal spot white, stained with buff at their extremities and on the veins; outer edge of the postdiscoidal patch black, forming three sharp angles; costal area beyond it blackish, interrupted by the subapical spot; reniform spot blackish and ill-defined; external area pale, sprinkled near the margin with white scales, its inner edge widely undulated; a series of ill-defined black marginal dots, barely distinguishable from a slender blackish marginal line; fringe flecked with white: secondaries with the basi-abdominal half pure white, slightly opaline, the median and submedian veins streaked with brown; external half dark greyish brown, the outer margin from apex to below first median branch snow-white, interrupted at the centre of the margin by a large black spot which extends into the fringe; remainder of fringe (excepting at anal angle, where it is grey-brown) white; head, palpi, and front of anterior legs clear pale buff; collar buff in the middle, grey-brown at the sides; thorax deeper sordid buff, the tegulae with brown-tipped scales; abdomen sericeous whitish buff. Under surface snow-white; the outer third of the primaries and an oblique bar from its posterior extremity across the end of the cell to the costal vein deep bronze-brown; a white subapical spot as above and the fringe spotted with white: secondaries as above, excepting that there are no dusky streaks across the basal area on the veins.

Expanse of wings 37 millim.

Aden (*Major Yerbury*). Type in B. M.

This very well-marked and charming species is named in honour of Major J. W. Yerbury, whose generosity in placing the whole of his collections of Lepidoptera at the disposal of the Museum has been of the greatest service in adding numerous novelties to the collection.

The position of *M. Yerburyi* is undoubtedly near to *M. inepta* and *flexuosa*, but it is decidedly more striking and beautiful than either.

* Possibly an optical illusion, due to the proximity of buff on the white markings.

BIBLIOGRAPHICAL NOTICES.

The Study of Animal Life. By J. ARTHUR THOMSON, M.A. &c.,
Lecturer on Zoology, School of Medicine, Edinburgh. London :
John Murray, 1892.

THIS little volume of some 370 pages forms one of the University Extension Manuals edited by Prof. Knight, who states in a preface that the series is intended "to supply the need so widely felt by students, of text-books for study and reference, in connexion with the authorized courses of lectures. The Manuals differ from those already in existence in that they are not intended for school use or for examination purposes; and that their aim is to educate, rather than to inform." Admitting that there is a need for such a series of volumes—and the objects as set forth in the editorial preface are certainly very laudable—let us consider how far Mr. Thomson's work fulfils the requirements of the case.

The book is divided into four parts and twenty chapters. Its scope will be to some extent realized from the headings of the parts, which are (I.) The Everyday Life of Animals; (II.) The Powers of Life; (III.) The Forms of Animal Life; and (IV.) The Evolution of Animal Life. There are in addition two appendices entitled respectively "Animal Life and Ours" and "Some of the Best Books on Animal Life." These headings give but a very imperfect notion of the contents of the volume, which attempts to cover the whole ground of animal biology. The scope in fact is so wide that the treatment is and could not be otherwise than sketchy. The reader who peruses the pages with the object of assigning to the work its correct place in biological literature will experience the same difficulty that we have met in deciding whether the author is aiming at popularity or whether he is endeavouring to supply an elementary text-book with all the technicalities of the science cut out. Whatever his aim, the result on the whole is, it must be confessed, somewhat disappointing. The book is not popular enough in our opinion to convert a would-be student into a biologist, while it is too sketchy to be of much real use to an earnest reader. It is unfortunately one of those productions which are calculated to spread broadcast throughout educated classes the glib patter of the scientific workshop which superficially passes for real knowledge. This is no doubt very far from the author's intention; but the effect cannot be otherwise when in the course of one small volume the reader is conducted over the whole range of subjects referred to in the contents, that is, the entire field of animal biology, including morphology, embryology, physiology, psychology, sociology, &c.

The defects which have been pointed out are to a very great extent, or perhaps entirely, due to the system for which Mr. Thomson has undertaken to cater. Making allowances for the work from this point of view it must be admitted that there are certain sections here and there which indicate considerable originality, and which show

that the author is capable of doing good service to biological science as a thinker under more favourable conditions than those imposed by University Extension lecturing. As a specimen of judicious treatment we may refer to the summing-up of the cell-theory in the chapter on "The Elements of Structure" (p. 183):—

"We study the nucleus, first as a simple unit which divides, years afterwards as composed of a network or coil of nuclear threads which seem ever to become more and more marvellous, 'behaving like little organisms.' We split these up into 'microsomata' and so on, and so on. But we do not catch the life of the cell, we cannot locate it, we cannot give an account of the mechanics of cell-division. It is a mystery of life. After all our analysis we have to confess that the cell, or the protoplasm, or the archoplasm, or the chromatin threads of the nucleus, or the 'microsomata' which compose them baffle our analysis; they behave as they do because they are alive."

The tabular summaries, such as those showing the characteristics of animals and plants (p. 170), the survey of the animal kingdom (p. 272), the tree of life (p. 12), the summary of evolution theories (p. 302), &c. are also worthy of commendation.

As a fair average sample of the author's method we give the following extract from his treatment of the resemblances and differences between animals and plants (p. 171):—

"The net result of this contrast is that animals are more active than plants. Life slumbers in the plant; it wakes and works in the animal. The changes associated with the living matter of an animal are seemingly more intense and rapid; the ratio of disruptive power-expenditure to constructive power-accumulating changes is greater; most animals live more nearly up to their income than most plants do. They live on richer food; they take the pounds which plants have accumulated in pence, and spend them. Of course plants also expend energy, but for the most part within their own bodies; they neither toil nor spin. They stoop to conquer the elements of the inorganic world, but have comparatively little power of moving or feeling. They are more conservative and miserly than the liberally spendthrift animals, and it is possible that some of the most characteristic possessions of plants, *e. g.* cellulose, may be chemical expressions of a marked preponderance of constructive and up-building vital processes. It is enough, however, if we have to some extent realized the commonplaces that plants and animals live the same sort of life, but that the animals are on an average more active and wide-awake than the plants."

We have already pointed out the general meagreness of the treatment given to the different portions of the work, necessitated by the compression of a very wide subject into a very small compass. An example will serve to indicate the defect to which we allude. Chapter IX. is headed "The Divided Labours of the Body." As subheadings appear the following:—1. Division of Labour. 2. The Functions of the Body: Movement; Nutrition; Digestion; Absorption; The Work of the Liver and the Kidneys; Respiration; Circulation; The Changes within the Cells; The Activities of the Nervous System. 3. Sketch of Psychology.

Here are materials for complete works on physiology and psychology. *The whole of these subjects are disposed of in nine pages!* Really scientific men may fairly ask what manner of use this kind of instruction serves.

Quite apart from these graver sins of compression, for which, as we have said, the author is not altogether responsible, there are certain minor blemishes which it is our duty to point out. In the first place, we are of opinion that the plan of giving quotations from other works without indicating their origin is most objectionable. The only effect which this can produce upon the mind of the student is that the author has either failed in power of expression, or that he is giving the actual words of some writer whom he regards as an authority. The latter is no doubt the true state of the case; but the reader is in many instances left quite in the dark as to the source of Mr. Thomson's inspiration—he is only allowed to infer that the words are not the author's by being suddenly plunged into a sentence between inverted commas. This occurs many times throughout the work. Thus, for all the student can gather, the passages quoted on p. 52 might be from Poulton or from any other author; the quotation referring to Joule on p. 131 has apparently dropped in promiscuously from some source known to the author but carefully hidden from his readers. Examples of this defect might be multiplied did space permit.

Then, again, the style occasionally lapses from the scientific to the metaphysical, to the everlasting confusion of the student. Under the heading "Vitality" (Chap. VIII.) and the subheading "The Task of Physiology" (p. 126) we read as follows:—

"Thus the star-like crystals of a snowflake, the diamond drops of dew, the overshadowing mountains, would all be imaged in our minds as living, though of more lowly life than the lichens of the bare hill-tops, the grass of the plains, or man himself."

Again, on p. 142, under the subheading "Origin of Life":—

"Matter in motion is accompanied by consciousness in ourselves. We infer a similar consciousness in creatures like ourselves. As the movements and the matter differ from those that occur within our body, so will the accompanying consciousness. The simplest state of affairs, or 'body' we can imagine is that of a gas such as hydrogen. But such a simple state of matter may have its accompanying consciousness, as different from ours as is the structure of our bodies from that of a hydrogen molecule. This is of course also an assumption, but it is one that harmonizes with the facts of experience."

We question the advisability of introducing fragments of German metaphysics into an elementary manual intended for students attending a University Extension course on animal life. Many other mystical passages have been noted during our perusal of the book, but it is unnecessary to quote any further illustrations.

In matters of fact the author is, on the whole, fairly accurate, and there are but few statements to which exception can be taken. Among the errors we have noticed may be pointed out the state-

ment on p. 28 that Darwin prophesied the existence of a *butterfly* in Madagascar with a proboscis 11 inches long; that "the only ugly animals are the products of domestication and human interference on the one hand, or of disease on the other" (p. 17); and that the term "balance of nature" is "very generally used to describe the mutual dependence of plants and animals" (p. 19). Further, Seitz's observations on the general tendency of the insects in a certain Brazilian region to become blue, and in an adjacent region red, have nothing whatever to do with the question of "resemblance to surroundings" (p. 49). Is the statement on p. 313, that all the annual progeny from one *Aphis*, if they survived and multiplied at the same rate as the parent, "would weigh down 500,000,000 stout men," the result of an actual calculation or simply a metaphorical way of stating that they would weigh a large number of pounds? If it is numerically true, the details of the calculation should be given. Taking the weight of a "stout man" as 150 lb., it will be found that the total *Aphis* progeny according to the above figures would weigh 33,482,143 tons.

Among the most favourable specimens of the author's power of exposition is the chapter on Heredity (Chap. XX. p. 320), in which the main facts and principles of this all-important subject are discussed and presented in a very lucid manner. The Darwinian doctrine is herein rejected in the following terms:—

"I am certainly unable to reconcile myself to the opinion that the progress of life is due to the action of natural selection on fortuitous, indefinite, spontaneous variations.

"I believe that the conclusion of the whole matter should be an emphatic 'not proven' on either side, while the practical corollary is that we should cease to talk so much about possibilities (in regard to which one opinion is often as logically reasonable as another), and betake ourselves with energy to a study of the facts."

No doubt this is sound advice; but it is remarkable that the author, who is sceptical with regard to natural selection, should declare with respect to the far more obscure problem of the origin of life (p. 136) that "the first stuff that was complex and unstable enough to be properly described as living was almost certainly formed in water, long ago, when the conditions of greater heat, and consequently greater mobility of all substances, made chemical changes more active."

The list of "best books" which the student is referred to in Appendix II. is simply appalling; we think some judicious pruning is required here, unless some means can be found for considerably prolonging the life of the biologist of the future.

We regret that we are unable to recommend this new work of Mr. Thomson's in higher terms; it is not altogether without merit, but it is fanciful in parts and occasionally mystical to the verge of incomprehensibility. The would-be student of animal life will find himself better off if he selects a few of the "best books" recommended by the author.

Rhopalocera Exotica ; being Illustrations of New, Rare, and Unfigured Species of Butterflies. By H. GROSE SMITH and W. F. KIRBY. Vol. I. London : Gurney and Jackson, 1887-1892.

THE completion of the first volume of this work affords a fitting opportunity for a brief notice of it. The work, as mentioned by the authors in their preface, is in effect a continuation of the well-known 'Exotic Butterflies' of the late Mr. W. C. Hewitson, which closed with the completion of the fifth volume in 1876, and, like that book, has made its appearance regularly in parts published quarterly.

Mr. Grose Smith's magnificent collection of *Rhopalocera* is well known to lepidopterists, and is constantly receiving important accessions from all parts of the globe; and it is greatly to his credit that he perseveres in making these numerous new and rare forms known to entomologists by means of such excellent coloured figures as those which adorn this sumptuous publication.

The volume before us contains no fewer than sixty hand-coloured plates, depicting 186 species. Both the upper and under surfaces are invariably given; and, as the figures represent the butterflies *naturally*—that is to say with the full expanse of the upperside and also with folded wings as when the insect is settled—both the dorsal and lateral aspects of the head and body are shown, as well as the wings, a point of no little importance to a student of the group, but one which the economical and convenient modern plan of exhibiting the butterflies asymmetrically, half upperside and half underside, entirely excludes. The figures generally are most accurate and characteristic, and the colouring is throughout of unusual excellence. Especially fine is the rendering of the upper surface of the splendid *Morpho helena*, where texture, internervular folds, and shifting glitter of metallic blue tints are delineated with remarkable skill and success. It is of interest to note that three fourths of these admirable plates were drawn on the stone by Mrs. Monteiro, an enthusiastic collector and student of butterflies, whose recently published work on 'Delagoa Bay' has made widely known not alone her artistic and literary ability, but also her keen observant powers as a naturalist. All will share the regret expressed by the authors that failing health compelled this accomplished lady to relinquish the artistic work in which she so excelled.

It is not within the scope or expressed intention of this book to do more than describe and illustrate new or rare species, and it must be admitted that, apart from occasional insufficiency in the descriptive part, the object in view has been carried out most effectually. Yet every naturalist cannot but wish for something more than this, something to relieve the baldness and monotony of the text, and to tell him a little of the haunts and habits of the brilliant and delicate creatures so exquisitely portrayed. There can be no doubt that the interest of the work would be vastly increased, as well as its value to zoologists, if, without going into much detail, the brief notes

which most experienced collectors make of stations, dates of capture, abundance or scarcity, plants frequented, &c. could be introduced. Such important particulars, if not made use of when the specimens are described, are only too apt to be lost altogether; their addition to the text would involve but little more expense, and would certainly increase the sale of the work, which we regret to learn is at present far more limited than its great merit demands.

We cannot omit, in concluding, to draw especial notice to a most valuable feature of 'Rhopalocera Exotica,' viz. the large space in this volume devoted to the illustration of African Lycenidæ. The Ethiopian Region stands alone in the number of aberrant genera of this family which are peculiar to it; but it is only quite recently, since the tropical area has been better investigated, that its wealth in *species* has come to light. As many as eighty-four species, allotted to twelve genera, are figured on the seventeen plates assigned to this family, and, as many of these are small, obscure, and closely-allied forms, it is of signal service to the lepidopterist to have such good figures of them provided.

R. T.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

June 22nd, 1892.—W. H. Hudleston, Esq., M.A., F.R.S.,
President, in the Chair.

The following communications were read:—

1. "Mesosauria from South Africa." By Prof. H. G. Seeley, F.R.S., F.G.S.

The Author gives an account of specimens of *Mesosaurus pleurogaster* (Seeley) obtained from the shales at the Kimberley diamond-mine. They are of small size, and show generic identity with the Paris type, but indicate an animal with a long tail, with the hind limbs well developed. The centrums of the vertebræ are barrel-shaped, contracting to the articular faces, which are conically cupped. The dorsal ribs have the usual subcylindrical character and development; but the abdominal armour is more like that of a Plesiosaur, only the sternal ribs are thin and flat. The vertebræ appear to give attachment to the dorsal ribs in an unusual way, which suggests the condition in the Theriodontia, but without distinct tubercles or facets; so that the slender head of the rib lies in the depression between two centrums. In the early caudal vertebræ the transverse processes are stronger, the neural spines long and compressed, and chevron bones well developed. Details are given of the structure of the tarsus and hind limb.

A new example of *Mesosaurus tenuidens* from Albania, preserved in the South African Museum, shows many details of structure

more perfectly than in the type-specimen; and the Author describes the skull, cervical and dorsal vertebræ, shoulder-girdle, ribs, and fore limbs. The forms of the cervical ribs are determined, and the composite structure of the scapular arch shown to have characters in common with that of *Dactylosaurus*, *Stereosternum*, and *Plesiosaurus*. The humerus closely resembles that of the edentate *Megalonyx* before its epiphyses are ossified. There are four bones in the distal row of the carpus, and three bones in the proximal row. The characters of the dorsal surface are given from a specimen preserved in the Albany Museum.

The Author then discusses the relation of *Mesosaurus* to *Stereosternum*, as preserved in the British Museum, arriving at the conclusion that the two genera are distinct, defined by characters drawn from all parts of the skeleton. *Stereosternum* has four sacral vertebræ, with the ilium extended far in front of the acetabulum. The coracoids are regarded as meeting in the median line, and not by overlap as in the thin ossification of *Mesosaurus*. In both genera there are five bones in the distal row of the tarsus.

The Author concludes that these types are closely allied to *Neusticosaurus*, which he would separate from the Nothosauria and unite with the Mesosauria. That group is subdivided into two divisions—the Proganosauria of Baur, and the Neusticosauria; the former being known from South Africa and South America, and the latter from Europe only.

2. "On a new Reptile from Welte Vreden, *Eumotosaurus africanus* (Seeley)." By Prof. H. G. Seeley, F.R.S., F.G.S.

The Author obtained the specimen described at Welte Vreden, near Beaufort West, Cape Colony, where it was found by Mr. L. Pienaar in beds of Middle Karoo age. It indicates a small animal, and shows the dorsal ribs, vertebræ, and part of the pelvis. The centrums are more slender than in any known South African fossil, and conically cupped at the ends as in *Mesosaurus*, &c. There is no indication of great transverse widening of the neural arch. The neural spine is compressed. The ribs appear to have been attached much as in Chelonians, though the articulation is not seen. They are remarkably massive, long, wide, compressed above, and sub-triangular in transverse section. There may be some sternal ribs. The os pubis is thin and flattened, with a notch on the outer hinder border like that seen in Mesosauria. The genus is probably referable to that group, but distinguished from all known genera by the forms of the vertebræ and ribs.

3. "On the Structure of the American Pteraspidian, *Palæaspis* (Claypole), with Remarks on the Family." By Prof. E. W. Claypole, B.A., D.Sc., F.G.S.

After reviewing the discovery of *Palæaspis* and noticing cases where Scaphaspis plates had been referred to ventral plates of Pteraspidian fish, the Author describes two specimens of his genus *Palæaspis* from the Onondaga group (referred to the Lower Ludlow)

which indicate the existence of a ventral plate in this genus. The evidence in favour of this interpretation is given at length, and the fossil originally described as *P. bitruncatu* is maintained to be the Scaphaspid plate of *P. americana*.

The existence of lateral plates and of lateral organs ('fins') is also discussed, and a comparison made between *Palaeaspis* and other Pteraspids. The Author attempts a restoration of *Palaeaspis*, and gives an amended definition of the genus.

4. "Notes on some New and Little-known Species of Carboniferous *Murchisonia*." By Miss Jane Donald.

In a previous paper, the various sections into which it has been considered advisable to group different species of *Murchisonia* have been noticed. Of the species described in the present communication, two only can be undoubtedly referred to *Goniostropha* of Ehlert. Others have the sinus situate above the angle; and if this position of the sinual band be considered sufficiently distinctive, the Authoress suggests the name *Hypergonia* for this section, and takes *Murchisonia quadricarinata* as the type.

The following new forms are described:—*Murchisonia* (*Goniostropha*) *hibernica*, *M. (G.) Tatei*, *M. (Hypergonia) quinquecarinata*, De Kon., var. *pulchella*, *M. (H.) conula*, De Kon., var. *convexa*, *M. (H.) pentonensis*, *M. (H.) Kirkbyi*, *M. (H.) plana*, *M. (Caeloculus?) tuedia*.

A fuller description is also given of a species previously described by Prof. Haughton under the name of *Cerithoides telescopium*.

5. "Microzoa from the Phosphatic Chalk of Taplow." By F. Chapman, Esq., F.R.M.S.

Ninety-eight species and varieties of foraminifera, and five species and varieties of ostracoda have been found in this deposit. All the forms of ostracoda have been previously found in the Chalk. Of the 98 varieties of foraminifera 5 appear to be new, whilst altogether 30 are new to the Chalk fauna.

The following new forms are described:—*Nubecularia Jonesiana*, *Textularia decurrens*, *T. serrata*, *Bulimina trigona*, and *Bolivina strigillata*.

MISCELLANEOUS.

Additional Note on the Occurrence of Lichia vadigo on the Cornish Coast. By Dr. A. GÜNTHER, F.R.S.

IN the Ann. & Mag. Nat. Hist. 1889, iii. p. 107, I reported the capture of a specimen of *Lichia vadigo* off the Isle of Skye, noticing it again in the Proc. Zool. Soc. 1889, p. 50, and accompanying that note with a figure of the fish. I have now the pleasure of recording the capture of a second specimen on the south-west coast

of England. My attention was drawn to it by a letter from Mr. W. Hearder, of Plymouth, which appeared in the 'Field' and other newspapers of August 27th, and in which the fish is described as the "Glaucus" (*Lichia glauca*). However, on being kindly shown the fish by Mr. Hearder, I recognized it as a *Vadigo*.

The preservation of this specimen is due to the Very Rev. Canon H. H. Du Boulay, of Prussia Cove, Marazion, who states that it was caught on August 23rd in a pollack-net off Prussia Cove. The discoverer generously at once acceded to my request of depositing it in the British Museum. The fish is in excellent condition and nearly of the same size as the one obtained in 1888, viz. 19 inches.

I may mention on this occasion that during the summer of the present year fresh specimens of *Centrina Salviani* were exposed for sale in the markets of London as well as Plymouth. As one or two individuals of this shark are known to have been caught on the British coast some years ago, it is of importance to know that the specimens of the present year were not British, but, as Mr. Calderwood, the Director of the Laboratory of the Marine Biological Association, informs me, were brought by trawlers who fish in or about the Bay of Biscay, carrying their fish into British ports. Exposure for sale in a fresh state in the London markets has ceased to be evidence of a fish having been obtained within the British area.

P.S.—Mr. G. A. Musgrave, Pres. Torquay Nat. Hist. Soc., has kindly informed me that two other specimens of the *Vadigo* were obtained on the South Devon coast simultaneously with the Cornish specimen, viz. in Babbicombe, and the other in Oddicombe Bay.

On the Stridulating-apparatus of the Red Ocypode Crab. By
A. ALCOCK, M.B.

Several years ago Professor Wood-Mason demonstrated to me the fact, that in both males and females of the red *Ocypode* crab that swarms on all the sandy shores of India, the bigger of the two chela, or nippers, bears across the "palm" a long finely-toothed ridge, and on one of the basal joints of the "arm" against which the "palm" can be tightly closed, a second similar ridge; and that, when the "palm" is so folded against the base of the "arm," the first ridge can be worked across the second, like a bow across a fiddle—only in this case the bow is several times larger than the fiddle.

The remarkable resemblance of the whole arrangement to the stridulating-apparatus of many insects, led Professor Wood-Mason, who is an authority on the subject, to infer a similarity of function; and Professor Wood-Mason requested me to observe the crabs during life, and to listen for the sounds which he supposed them to be capable of producing. I have this season heard the sounds, and I am now able to give the actual facts that establish the truth of Professor Wood-Mason's *à priori* inference. In order to understand the value, and what may be called the evolutionary coefficient, of

such an apparatus, the life-history of these crabs must first be briefly noticed.

They are gregarious, and though at times they may be seen marching (migrating?) in battalions across the sand, they usually live in "warrens" at and about high-water mark, where they excavate tortuous burrows, methodically turning over the surface of the surrounding sand for any particles of food that it may contain, and when alarmed flying each one to its burrow. Their chief enemy appears to be the common red-and-white kite. Now the use of the stridulating-organ appears to be this, that when a crab has entered its burrow it may, by the utterance of warning notes, prevent other crabs from crowding in on top of it. It is easy to imagine that, in the consternation of a sudden hostile surprise, several crabs might fly for refuge to the same burrow, with the result that both the lawful occupant and the intruders might be stifled, or crushed, or in some way injured, and it is easy to understand that the power of uttering a warning signal would protect the lawful occupant from such harm. That, when intrusion does take place, the sound is feared by the intruder, I shall presently show.

The possible reciprocal advantage to the other crabs from such warning we must pass by, in discussing the origin of the stridulating-organ; for, although the crabs are gregarious, there appears to be no social co-operation whatever, and we can assume that individual structural modifications exist for the good of all the members of a flock only when there is social co-operation.

The sounds can be heard, and their effects seen, by forcing one crab, which we will call the intruder, into the burrow of another, which we will call the rightful owner. The intruder shows the strongest reluctance to enter, and will take all the risks of open fight rather than do so, and, when forced in, he keeps as near the mouth of the burrow as possible. When the rightful owner discovers the intruder he utters a few broken tones of remonstrance, on hearing which the intruder, if permitted, will at once leave the burrow. If the intruder be prevented from making his escape, the low and broken tones of the rightful owner gradually rise in loudness and shrillness and frequency until they become a continuous low-pitched whirr, or high-pitched growl, the burrow acting as a resonator.

One has often to wait quietly for a long time, until the alarm of the appearance of an enemy has subsided, before the rightful owner discovers the intruder and begins to stridulate; and had it not been for a happy accident I should not this season have repeated experiments that three years ago, owing to my impatience, were unsuccessful. I need hardly say that what little credit there is in this discovery is entirely due to Professor Wood-Mason, who directed my attention to the subject, and who has stores of knowledge accumulated upon stridulation in crustaceans. And in the 'Descent of Man,' p. 274 (2nd edition), there is a reference to Hilgendorf's discovery of possible stridulating-organs in the higher crustacea.—From the *Administration Report of the Marine Survey of India* for 1891-92.

*The Coxal Gland of the Scorpion and its Morphological Relations with the Excretory Organs of the Crustacea**. By M. PAUL MARCHAL.

We know that the coxal gland of the Scorpion consists of two portions, a medullary and a cortical substance.

The structure of the medullary substance has not yet been elucidated by authors. It presents two very distinct classes of lacunæ which have hitherto been confounded. The first of these are the glandular lacunæ: they are for the most part extremely narrow, and their lumen is often filled by glandular epithelium, which may cause them to pass unnoticed; this epithelium presents a similar aspect to that of the sac of the antennary gland of the Crustacea. The second kind are the blood-lacunæ: they are wide and may be distinguished at once from the former class by the fact that they are limited by a membrana propria separating the glandular epithelium from the sanguineous fluid, and appearing in sections as a refringent line; moreover the blood-lacunæ are often filled by a coagulum presenting a punctate appearance.

The glandular lacunæ anastomose with one another so as to constitute a spongy plexus, and open into a central lacuna much wider than the others; this larger lacuna plays the part of the ramified sac of the marine Decapod Crustacea, and inosculates directly with the long tube which constitutes the cortical substance.

This communication between the medullary and the cortical substance, the existence of which is of the greatest interest from the present point of view, had not hitherto been seen in the adult. It presents a striking analogy to that between the sac and the labyrinth of the antennary gland of the Crustacea. Around the orifice we find the same clear columnar cells, swollen at their free extremity and narrow at their base; the passage between the epithelia of the two portions which are so different from one another is equally effected without a noticeable transition: immediately the orifice is passed we meet with the cells which are striated in their basal portion and are characteristic of the cortical substance.

In the Crustacea, at least in the Decapods, which are the only ones that I have studied, the sac is perfectly isolated, and it is always possible to distinguish its epithelium from the connective tissue, otherwise much reduced, which surrounds it. It is not the same with the medullary substance of the coxal gland of the Scorpion: at its periphery, and especially at the level of its anterior portion, which is free and constitutes the hilum of the gland, the glandular lacunæ become purely virtual intercellular passages, and end by being entirely filled up; from this there results the formation of

* The species which was the subject of my observations was *Scorpio occitanus*. For the specimens upon which this investigation was conducted I am indebted to the kindness of Prof. de Lacaze-Duthiers, who had them sent to me alive from the Arago Laboratory at Banyuls-sur-Mer.

clusters of cells which become insensibly united with the surrounding connective tissue, without its being possible to say where the glandular tissue commences and where the connective tissue ends. It was on account of this arrangement that Ray Lankester, who, moreover, was not aware of the communication between the medullary and the cortical substance, and of the double lacunar system constituted by the sanguineous and the glandular lacunæ which I have just described, regarded this medullary substance as being formed by a connective tissue of a special kind, the nature of the empty spaces of which remained problematical to him: nevertheless his shrewdness led him very justly to consider this medullary substance as probably corresponding to the sac of the antennary and shell-glands of the Crustacea.

The structure of the cortical substance of the coxal gland of the Scorpion is actually known. I shall therefore confine myself to stating that the injections which I have made of it with celloidin and asphalt have entirely confirmed the current opinion, which regards this substance as being formed of an extremely long tube coiled a very great number of times upon itself. The mould which is obtained by this method gives a demonstration of this structure which is conclusive in a very different way from that hitherto derived by authors from the method of sections. This tube communicates by one of its extremities with the medullary substance, and I may remind the reader that, as has recently been shown, it opens to the exterior by the other at the level of the base of the third pair of limbs.

The secretion of the cortical substance is effected by elimination of large vesicles at the extremity of the cells in a manner similar to that which we have described in the Crustaceans. The cells of the medullary substance frequently present sharp constrictions, or a biscuit-shape, which indicate a mode of secretion analogous to that of the sac in many of the Decapods.

Conclusion.—It follows from the foregoing that the antennary and shell-glands of the Crustaceans, as well as the coxal gland of the Arachnids, may with reason be considered as organs of the same nature. The morphological significance of the sac of the Crustaceans is moreover found to be elucidated by the study of the medullary substance of the coxal gland of the Scorpion; and the opinion of Lankester, who was led to consider the epithelium of the sac as being formed by differentiated connective tissue, its cavity being a portion cut off from the coelome, isolated and adapted to excretion, thus receives entire confirmation: the glandular lacunæ of the medullary substance of the Scorpion may in fact be considered as being excavated in the midst of a differentiated connective tissue.

The antennary gland of the higher Crustaceans, the shell-gland of the lower, and the coxal gland of the Arachnids, communicating, as we have seen, on the one side with the exterior, on the other with a cavity which may be considered as a derivative of the coelome, may be regarded with much probability as forming part of a meta-

meric series comparable to that of the segmental organs in the Worms.—*Comptes Rendus*, t. cxv. no. 3 (July 18, 1892), pp. 191–193.

On the Freshwater Fauna of Iceland.

By MM. JULES DE GUERNE and JULES RICHARD.

In spite of their extreme abundance, and although numerous explorations have been made in the country, the fresh waters of Iceland have never been properly studied from a zoological point of view. M. Charles Rabot was able partly to supply this deficiency in the course of a scientific mission carried out in 1891, during the months of July and August. The collections were made in three different districts of the island:—(1) in the north, at Akureyri; (2) in the west, in the vicinity of Reykjavik; (3) in the east, in the region of the Eskifjord. The examination of them enables us to add *twenty-nine* species to the Icelandic fauna, among which the Entomostraca, which are by far the most numerous, amount to *twenty-six* (16 Cladocera, 8 Copepoda, 2 Ostracoda). The remainder include only 2 Rotifera and 1 Protozoon. Not one of these forms is new, but several of them are of genuine interest for different reasons which are stated below.

It is worth noticing in the first place that a certain number of species which are common throughout the whole of Europe (and even in the United States) are found in the three regions of Iceland visited by M. Rabot. These are *Simocephalus vetulus*, O.-F. Müller; *Alona affinis*, Leydig; *Chydorus sphaericus*, Jurine; *Cyclops strenuus*, Fischer; *C. viridis*, Fischer; and *C. serrulatus*, Fischer. Certain other forms, which are likewise very widely distributed in Europe, appear to be rarer in Iceland. *Daphnia longispina*, Leydig, *D. pulex*, de Geer, and *Cypris pubera*, O.-F. Müller, for instance, were only found in the Lake of Reykjavik in the case of the first, and at Akureyri in that of the other two. On the other hand, *Eurycercus lamellatus*, O.-F. Müller, *Acroperus leucocephalus*, Koch, *Pleuroxus excisus*, Fischer, and *Polyphemus pediculus*, de Geer, are absent only in the latter of these localities. *Alona testudinaria*, Fischer, a tolerably rare form, and *Cyclops fuscus*, Jurine, were only found in the east. *Pleuroxus nanus*, Baird, on the contrary, was met with only in the western region. *Cyclops fimbriatus*, Fischer, lives in the pit of a spar-mine near Eskifjord equally as well as in the waters of the Langarvatn, where there is also found, just as in the Lake of Reykjavik, an undetermined species of *Canthocamptus*. *Cypris aculeata*, Lilljeborg, is found in great abundance on the shores of the same lake.

Near Reykjavik, in Lake Thingwalla, which is the largest in Iceland, M. Rabot collected the following Crustaceans:—*Scapholeberis mucronata*, O.-F. Müller; *Bosmina arctica*, Lilljeborg; *Eurycercus lamellatus*, O.-F. Müller; *Acroperus leucocephalus*, Koch; *Alona affinis*, Leydig; *Chydorus sphaericus*, Jurine; *Polyphemus pediculus*, de Geer; *Diaptomus minutus*, Lilljeborg; *Cyclops strenuus*,

Fischer; *C. viridis*, Fischer: and *C. serrulatus*, Fischer. In the same region lies the Laugarvatn Lake, from which sulphurous thermal springs arise. Here M. Rabot captured, at a spot where the water attained the temperature of 19° C.: *Sida crystallina*, O.-F. Müller; *Macrothrix* sp.?; *Alona affinis*, Leydig; *Eurycerus lamellatus*, O.-F. Müller; *Pleuroxus nanus*, Baird; *Cyclops viridis*, Fischer; *C. serrulatus*, Fischer; *C. fimbriatus*, Fischer; and *Canthocamptus* sp.? With the living specimens there was obtained in the neighbourhood of the mineral and warm springs a very large quantity of remains of the same Entomostraca, whence we may conclude that the animals live only at a certain distance from these springs; their existence is menaced as soon as they approach them for any reason whatever.

Holopedium gibberum, Zaddach, which it is extremely interesting to meet with in Iceland, was found only at the most elevated point of the plateau which separates the Seydisfjord from the Lagarfljot (eastern region), in a pool a few centimetres deep, with a sandy bottom and bordered with marsh-plants. This Cladoceron was hitherto considered as one of the most characteristic forms of the pelagic region of the great lakes. Moreover it occurs, in the case in question, in company with *Diaptomus minutus*, Lilljeborg, and a variety of *Cyclops strenuus*, Fischer, both species and variety having a pelagic facies. In the same pool, in which the temperature of the water was 9° C., *Diaptomus glacialis*, Lilljeborg, was also very abundant. An analogous condition of things is exhibited by a sheet of peaty water in the valley of the Lagarfljöt; here we find associated together *Bosmina arctica*, *Diaptomus minutus*, and *D. glacialis*, with the variety of *Cyclops strenuus* mentioned above, in addition to certain pelagic Rotifera, *Asplanchna helvetica*, Imhof, and *Anurea* sp.?, for example, and a Protozoon, *Ceratium longicorne*, Perty, not to speak of several common littoral forms which have already been enumerated.

In accordance with our directions M. Rabot did not fail to search for specimens with a very small net in the puddles of water only 1 or 2 centim. deep and 7 or 8 centim. broad, situated on the cone of the great geyser; but nothing alive was obtained there. As for the other geysers, their waters flow rapidly away towards the Hvita without forming any pools.

The most remarkable general fact concerning the fauna of the fresh waters of Iceland is unquestionably the mixture of the Entomostraca of the arctic with those of the temperate zone. Within the high latitudes in the Commander Archipelago (Behring Straits) and in Greenland there occurs, among other forms, *Eurycerus glacialis*, Lilljeborg. We might expect to meet with this Cladoceron in Iceland; nevertheless it is not found. Everywhere, in the east as in the west of the island, it is the common *E. lamellatus*, O.-F. Müller, so widely distributed in Europe, that constantly appears. On the other hand, characteristic arctic species, such as *Bosmina arctica*, *Diaptomus minutus*, and *D. glacialis*, are very common in Iceland. The only localities hitherto known for the two Calanidae

last mentioned were the Island of Waigatsch and Nova Zembla in the case of the first and Greenland and Newfoundland in that of the second*.

In conclusion, the researches of M. Charles Rabot furnish us, in the first place, with new and precise evidence for zoological geography, and, secondly, enable us to assert that the fauna of the fresh waters of Iceland, in that which especially concerns the Entomostraca, presents mixed characters, recalling at once the analogous faunæ of Europe and, although in a less degree, of North America, in the temperate and arctic zones. The explanation of this fact is apparently to be looked for in the climatological conditions of Iceland, since it lies, as we know, almost at the point of contact of the warm and cold currents of the North Atlantic †.—*Comptes Rendus*, t. cxiv. no. 6 (February 8, 1892), pp. 310-313: from a separate impression communicated by the Authors.

On a Sporozoon parasitic in the Muscles of Decapod Crustacea.

By MM. F. HENNEGUY and P. THÉLOHAN.

In 1888 one of us ‡ mentioned the existence of sporozoon parasites in the muscles of *Palamon rectirostris* and *P. serratus*. The infected individuals are distinguishable at a glance by their opacity; they are of a chalky white, which contrasts with the normal transparency of these Crustacea. This opacity is due to the existence in the bundles of muscular fibrils of a considerable number of little granular masses. Each of these masses represents a little vesicle 10 μ in diameter, surrounded by a very delicate membrane and enclosing eight refringent corpuscles. The latter, which are slightly pyriform, measure from 3 to 4 μ in their greatest diameter. Their most swollen portion contains a clear vacuole, which occupies more than half of the corpuscle; the small extremity is constituted by a refringent substance. Owing to their aspect these corpuscles recall those of pebrine and the spores of certain Myxosporidia, such as those of the Gobies and the Stickleback. The fact that they are met with exclusively in the muscular fibres of the infected prawns had led us to assign these parasitic bodies to the Sarcosporidia, while at the same time regarding them as transitional between these on the one hand and the Microsporidia and Myxosporidia on the other.

Unfortunately all the specimens of *Palamon* which we had examined exhibited the parasite at the limit of its evolution, in the

* *Vide* J. de Guerne and J. Richard, "Sur la faune des eaux douces du Groënland" ('*Comptes Rendus*,' March 25, 1889), and "Revision des Calanides d'eau douce" (*Mém. Soc. Zool. de France*, vol. ii., 1889).

† Mohn, "Nordhavets Dybder, Temperatur og Strømminger" ('*Norske Nordhavs-Expedition*,' Christiania, 1887).

‡ Henneguy, "Note sur un parasite des muscles du *Palamon rectirostris*," *Mémoires publiés par la Société philomathique à l'occasion du centenaire de sa fondation*, 1888.

sporiferous stage, and we had no idea as to its mode of development.

In 1891 Garbini * found in the muscles of *Palæmonetes varians*, collected in the neighbourhood of Verona, a sporozoon very closely allied to that of *Palæmon rectirostris*; it appeared in the form of spindle-shaped vesicles enclosing eight pyriform spores. The author did not succeed in observing the first stages in the development of this parasite, which he regards as belonging to the Sarcosporidia.

At the same period one of us † mentioned the existence of parasites in the muscles of *Callionymus lyra* and of *Cottus scorpius*, and drew attention to the relations exhibited by these organisms with the parasite of *Palæmon* and that discovered by Gluge in the Stickleback, and for which he proposed the name *Glugea microspora*. By prosecuting the study of these sporozoa he has been able to determine the existence in the spores of *Glugea* of a capsule with a spiral filament ‡, an element which, as we know, is characteristic of the Myxosporidia. He has since succeeded in making the same observation with regard to the spores of the parasite of the muscles of *Cottus*.

It was therefore to be presumed that the parasite of the muscles of *Palæmon* likewise exhibited this character, and should also be assigned to the Myxosporidia.

An observation has quite recently been made which confirms this hypothesis and enables us to study the development of the spores.

Through the courtesy of Prof. Giard we have been able to examine a specimen of *Orangon vulgaris* from Boulogne, which exhibited the chalky appearance already mentioned in connexion with the infected prawns. On making a microscopical examination we found all the muscles invaded by a parasite identical in aspect with that of *Palæmon*, from which it differs only in being of larger dimensions, the spores measuring from 5 to 6 μ instead of from 3 to 4 μ .

In this case also the spores are arranged in groups of eight in vesicles with very delicate walls. They are pyriform and possess an envelope which resists potash, and their large extremity is occupied by a clear vacuole, as in the spores of the parasite of *Palæmon*, *Cottus*, &c.

By treating them with hydrochloric or nitric acid we have been able to determine the issue of a filament at the level of the small extremity. It is nevertheless very difficult to produce the omission of this filament, and we have only observed it a very few times in spite of repeated efforts in this direction.

In addition to the vesicles containing eight spores, which repre-

* Garbini, "Contributo alla conoscenza dei Sarcosporidi," *Reddiconti della R. Accad. dei Lincei*, vol. vii, February 1891.

† Thélohan, "Sur deux Sporozoaires nouveaux, parasites des muscles des Poissons," *Comptes Rendus de l'Académie des Sciences*, January 1891.

‡ Thélohan, "Note sur la *Glugea microspora*," *Comptes Rendus de la Société de Biologie*, January 30, 1892.

sent the ultimate limit of the evolution of the parasite, we have met with a whole series of younger stages, which has enabled us to follow the development of the spores, and thus to fill up the gap which existed in the history of the parasite of *Palæmon*.

Here, in fact, by the side of ripe spores we have observed little spheres of plasma, provided with a nucleus. These little elements are surrounded by a delicate envelope of a hyaline substance which resists the action of potash. They measure about $12\ \mu$ to $14\ \mu$ in diameter.

We soon observe that the nucleus loses its membrane and assumes the arrangement known as the chromatin wreath ("peloton chromatique"). We next witness the formation of an equatorial plate, then its division into two, and so on.

It is therefore seen that we are dealing with a case of fission by karyokinesis. We did not succeed in obtaining a clear view of the achromatin fibres, probably in consequence of the small dimensions of the elements. The indirect division of the nucleus in the Myxosporidia has, moreover, already been described by one of us*.

After the division of the nucleus the plasma soon divides in its turn, and we observe within the envelope two little nucleated masses. The same phenomena of fission are repeated, and by means of successive bipartitions we finally get within the envelope eight little nucleated masses, at the expense of each of which a spore will be formed. It is impossible to follow the formation of the latter in detail in consequence of its small dimensions.

To recapitulate our results. The organism which we have observed in *Crangon* must be assigned to the Myxosporidia, since its spores enclose an eversible filament.

It is interesting on account of its habitat, for Myxosporidia had not hitherto been stated to occur in Arthropods, except in *Tortrix viridana* by Prof. Balbiani.

This parasite is very closely allied to *Glugea* and to the parasites of *Cottus* and *Callionymus*; it differs from them by the constant number (eight) of spores which develop in each ripe vesicle.

It has enabled us to confirm the observations made by one of us with regard to karyokinesis in the Myxosporidia.

Lastly, it is so intimately related to the parasite of *Palæmon* that we may, we believe, extend to the latter the results of our observations.—*Comptes Rendus hebdomadaires des séances de la Société de Biologie* (Séance du 25 juin, 1892): from a separate impression, communicated by the Authors.

* Thélohan, "Recherches sur le développement des spores chez les Myxosporidies," *Comptes Rendus de l'Académie des Sciences*, November 1890 (*Ann. & Mag. Nat. Hist.*, March 1891, pp. 304-306).

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XL.—*Natural History Notes from H.M. Indian Marine Survey Steamer 'Investigator,' Lieut. G. S. Gunn, R.N., commanding.*—Series II., No. 5. *On the Bathybial Fishes collected during the Season of 1891-92.* By A. ALCOCK, M.B., Surgeon-Naturalist to the Survey.

[Plate XVIII.]

ON fifteen occasions during the course of her recent surveys of the Laccadive Islands and Coromandel coast the 'Investigator' carried out successful trawlings in the deep-sea. The fishes described in this paper were taken on twelve of these occasions, and as a preface to the descriptions of the fishes a brief notice of the principal features of the stations at which they were trawled may be given.

§ 1. *A brief notice of the Trawling-Stations.*

Station 121.—Laccadive Sea, lat. $14^{\circ} 35' 15''$ N., long. $72^{\circ} 02' 37''$ E., 1140 fathoms; bottom grey calcareous (coral) ooze; bottom temperature $37^{\circ} \cdot 5$ Fahr. A poor ground, except in Holothurians, of which some good specimens of *Benthodytes* and *Psychropotes* were taken, the gelatinous dorsal appendage of the latter being larger than the body of the animal itself.

Station 122.—Laccadive Sea, lat. $12^{\circ} 05' 55''$ N., long. $72^{\circ} 02' 37''$ E., 1140 fathoms; bottom grey calcareous (coral) ooze; bottom temperature $37^{\circ} \cdot 5$ Fahr. A poor ground, except in Holothurians, of which some good specimens of *Benthodytes* and *Psychropotes* were taken, the gelatinous dorsal appendage of the latter being larger than the body of the animal itself.

71° 33' 30" E., 865–880 fathoms; bottom *Globigerina*-ooze; bottom temperature 40° Fahr. The haul here was a good one; perhaps the most interesting capture was that of a small Terebratuloid Brachiopod with a branching peduncle forming a tuft which is so firmly anchored among foraminifera shells that masses of the latter still adhere to the detached specimens.

Station 126.—Laccadive Sea, lat. 8° 49' N., long. 73° 18' 45" E., 1370 fathoms; bottom calcareous (coral) ooze; bottom temperature 36° Fahr.

Station 127.—Laccadive Sea, lat. 8° 19' N., long. 73° 11' E., 1200 fathoms; bottom coral-ooze with many shells of foraminifera. This ground, close by the island of Minnikoy, was a very good one, especially for Asteroidea and Ophiuroidea, of which many specimens, of ten species, were taken.

Station 128.—Gulf of Manaar, lat. 6° 58' N., long. 77° 26' 50" E., 902 fathoms; bottom green mud, with very numerous chitinous annelid tubes, stout and over 6 inches long, many with their living occupants.

Station 129.—Bay of Bengal, lat. 16° 41' N., long. 82° 33' 45" E., 270 fathoms; bottom a red-brown ooze from the River Godáviri. Besides the *Macruri* and *Coloconger* and *Nettastoma*, which are characteristic of muddy stations at this depth in the Bay of Bengal, and besides the equally characteristic mollusks *Nucula* and *Amussium*, not very much was taken.

Station 130.—Bay of Bengal, lat. 16° 20' 40" N., long. 82° 19' 15" E., 281–258 fathoms; bottom river-borne mud; bottom temperature 51° Fahr.

Station 131.—Bay of Bengal, lat. 16° 01' N., long. 81° 25' E., 410 fathoms; bottom the same river-mud; bottom temperature 45°·5 Fahr. Besides the characteristic forms—*Macrurus investigatoris*, *Nettastoma taniola*, &c.—many specimens of a species of *Phormosoma*, and almost as many of a fine large species of *Ophiopeza*, were taken, as well as nine fine specimens of *Flabellum laciniatum*, Phil.

Station 132.—Bay of Bengal, lat. 12° 50' N., long. 81° 30' E., 475 fathoms; bottom a red-brown ooze brought down by the River Kistna; bottom temperature 45°·5 Fahr. Most worthy of mention are the fine Spatangoids (*Lovenia* or a close ally), of which more than a score of fine specimens were

taken. Several specimens of *Flabellum laciniatum*, Phil., also occurred.

Station 133.—Bay of Bengal, lat. $15^{\circ} 43' 30''$ N., long. $81^{\circ} 19' 30''$ E., 678 fathoms; bottom brown mud hardening into clay; bottom temperature 42° Fahr. Over one hundred fine specimens of a species of *Phormosoma* were taken, and many specimens of *Flabellum japonicum*, Moseley, and *Bathyactis symmetrica*, Pourtales.

Station 134.—Bay of Bengal, about 30 miles S.W. of the last, 753 fathoms; bottom brown mud hardening into clay; bottom temperature $41^{\circ} 2$ Fahr. *Phormosomas*, *Spatangoids*, and *Flabellum* corals were of noteworthy occurrence.

Station 135.—Off Konkan coast, lat. $15^{\circ} 29'$ N., long. $72^{\circ} 41'$ E., 559 fathoms; bottom green mud with a good many foraminifera shells; bottom temperature 47° Fahr. Here the most interesting captures were several specimens of *Brisinga*, a stalked Crinoid, and two individuals of a *Sipunculus* with ova floating free in the body-cavity. In a second haul, close by, some dead branches of a *Lophohelia* were dredged—the first Oculinoid coral reported from the coasts of India.

§ 2. Descriptions of the Fishes, with some brief notes on the Ova and on some peculiarities of the Enteric Mucosa of certain Deep-sea Fishes.

The bathybial fishes obtained during the season of 1891–92 number twenty-seven species, which include eight new to science. Of types not hitherto recorded from India there must here be noticed *Xenodermichthys*, *Leptoderma*, *Uroconger*, and, if the discovery of an empty egg-capsule be accepted as sufficient evidence, *Chimæra*.

Order CHONDROPTERYGII.

Suborder HOLOCEPHALA.

Family Chimæridæ.

CHIMÆRA, Linn.

1. *Chimæra monstrosa*, Linn.?

From Station 131, 410 fathoms, there comes an empty egg-capsule in very good preservation, which, from Dr. Günther's figure and description in the Ann. & Mag. Nat. Hist. for

December 1889, pp. 415-417, I identify as that of a *Chimæra*, probably *Chimæra monstrosa*, L. It is a little over 9 inches long, and, excepting for its larger size, in every other respect corresponds identically with that description.

Order ACANTHOPTERYGII.

Family Pediculati.

DIBRANCHUS, Peters.

2. *Dibranchus micropus*, Alcock.

Dibranchus micropus, Alcock, Ann. & Mag. Nat. Hist., July 1891, p. 25, pl. vii. fig. 2 (ventral fins too large).

One specimen from Station 128, 902 fath.

In this specimen the mouth is, in proportion, a little larger than it is in the type specimen taken last year in 240-276 fathoms, and the teeth are so minute, especially those in the premaxillary, as to be almost indistinguishable. The subopercular spine is large and complex.

It is interesting to find this species, indisputably ground-living, ranging from 240 to 902 fathoms.

Order ANACANTHINI.

Family Ophidiidæ.

Group BROTULINA.

PARADICROLENE, Alcock.

3. *Paradicrolene multifilis*, Alcock.

Paradicrolene multifilis, Alcock, Ann. & Mag. Nat. Hist., Nov. 1889, p. 387, and July 1891, p. 32.

Several specimens, of both sexes, from Station 130, 281 to 258 fathoms.

In young individuals the lower (free) rays are very much less clearly separated from the rest of the fin and from each other than in adults.

LAMPROGRAMMUS, Alcock.

4. *Lamprogrammus fragilis*, sp. n. ?

B. 8. D. circ. 90. A. circ. 75. C. 8? P. 17. V. 0.

Differs from *Lamprogrammus niger* (Alcock, Ann. & Mag. Nat. Hist., July 1891, p. 33, fig. 2) only in the following

particulars :—(1) the preoperculum is armed at its angle with three weak spines; (2) the length of the snout is barely twice the diameter of the eye, which is nearly one sixth the length of the head; (3) the length of the maxilla is not quite half that of the head; (4) the length of the trunk is hardly equal to that of the postrostral portion of the head; (5) the pectorals are large and long, reaching as far as the anal fin, but with regard to this difference it is as well to remark that the pectorals in our specimens of *L. niger* are much broken.

There is a small thick-walled air-bladder.

Colour jet-black.

A single male specimen, 19 inches long, from Station 133, 678 fathoms.

It is possible that this species may be the male of *Lamprogrammus niger*, of which three female specimens were obtained last year; and though it would be premature to decide that this is the case, yet the belief of its probability must be here recorded.

HEPIITHOCARA, gen. nov.

Head large, with thin, smooth, uncrested bones, scaleless. No armature but a weak opercular spine. Body compressed, tapering, covered with deciduous cycloid scales. Eye moderate. Snout not overhanging the jaws. Mouth with obliquely ascending cleft, and with the lower jaw prominent. Villiform teeth in the jaws, palatines, and vomer. No barbel or hyoid filaments. Gill-openings wide; gill-membranes separate; four gills, no pseudobranchiæ; eight branchiostegals. Lateral line indistinguishable. Vertical fins confluent; pectoral fins entire; no ventral fins.

5. *Hepithocara simum*, sp. n. (Pl. XVIII. fig. 1.)

Head of great relative size, deep, broad, and much inflated posteriorly, falling steeply in front to the small abruptly narrowed and depressed up-tilted snout; its length is about two ninths of the total without the caudal, and its greatest height posteriorly is a little over three quarters, and its greatest breadth a little over half, its length. The cranial bones are wafer-like and quite smooth, the only armature of the head being a flat spine at the upper part of the operculum.

The small snub snout, the end of which is formed by the projecting mandible, exceeds in length the width of the interocular space, this being about twice the major diameter of the

deep-set eye, which again measures about one eighth the length of the head. The nostrils are inconspicuous and are situated one in front of the angle of the eye, the other at the tip of the snout.

Mouth large, with its cleft obliquely ascending, and with the mandible projecting beyond the thin broad maxilla, which last in length is a little more than half that of the head. Villiform teeth in broadish bands in the premaxillæ and mandible, and in very narrow bands on the palatines and expanded head of the vomer.

Muciparous system of mandible and preoperculum highly developed.

Gill-openings extremely wide, the gill-membranes being entirely separated from each other and from the isthmus; eight branchiostegal rays; four gills, with narrow laminæ and short papilliform gill-rakers; pseudobranchiæ absent.

The head is covered with a delicate scaleless skin, which in life, owing to an extraordinary storage in and beneath it of mucus, forms a uniformly thick velvety cap. The nape and body are covered with membranous, deciduous, cycloid scales, of moderate size. No lateral line can be distinguished.

The fin-rays are all extremely delicate; the dorsal fin, which begins about a snout-length behind the level of the gill-opening, and the anal, which begins nearly a head-length behind the same level, are confluent with the caudal at its base. The narrow pointed pectorals are a little longer than the rostroribital portion of the head. There are no traces of ventrals.

Stomach subsiphonal and without any cæcal sac; no pyloric cæca; a large thin-walled air-bladder.

Colour uniform dark sepia; fins black.

An immature specimen, 8 inches long, from Station 128, 902 fathoms.

I have not attempted to give the radial formula, as no accurate determination could be made without sacrificing the unique specimen.

Hephthocara is to be classed with *Bellotia*, Giglioli (Zool. Anzeiger, vi. Jahrg., 1883, p. 399), *Alexeterion*, Vaillant (Expéd. Sci. du 'Travailleur' et du 'Talisman,' Poiss. p. 282), and *Lamprogrammus*, mihi, with all of which it agrees in the absence of ventral fins. From *Bellotia* and *Alexeterion* it differs, as these differ from one another, in the nature of the integument and in the nature of the dentition; it is further distinguished from *Bellotia* by its more numerous branchiostegal rays, by its small, almost rudimentary gill-rakers, by the absence of a lateral line, and by the rela-

tive proportions of the trunk; and from *Alexeterion* by this last character and by the well-developed eyes. It must be borne in mind, however, that both *Belletia* and *Alexeterion* were described from specimens under 50 millim. in length, a consideration which may well lead us to doubt the ultimate correctness of separating these three closely allied forms. *Lamprogrammus*, with its crested scaly head, its *Halosaurus*-like lateral line, and its very differently arranged viscera, is, I venture to think, quite distinct both from *Hephthocara* and from the other two genera of the alliance.

Family Macruridæ.

MACRURUS, Bloch.

Subgenus MACRURUS, Günther.

6. *Macrurus investigatoris*, Alcock.

7. *Macrurus semiquincunciatus*, Alcock.

8. *Macrurus macrolophus*, Alcock.

Specimens of all of the above, which were originally described in the Ann. & Mag. Nat. Hist. for November 1889, were dredged at Station 131, 410 fathoms.

9. *Macrurus Hextii*.

Macrurus Hextii, Alcock, Ann. & Mag. Nat. Hist., Oct. 1890, p. 209.

A large female specimen, nearly 23 inches long, from Station 122, 865 to 880 fathoms.

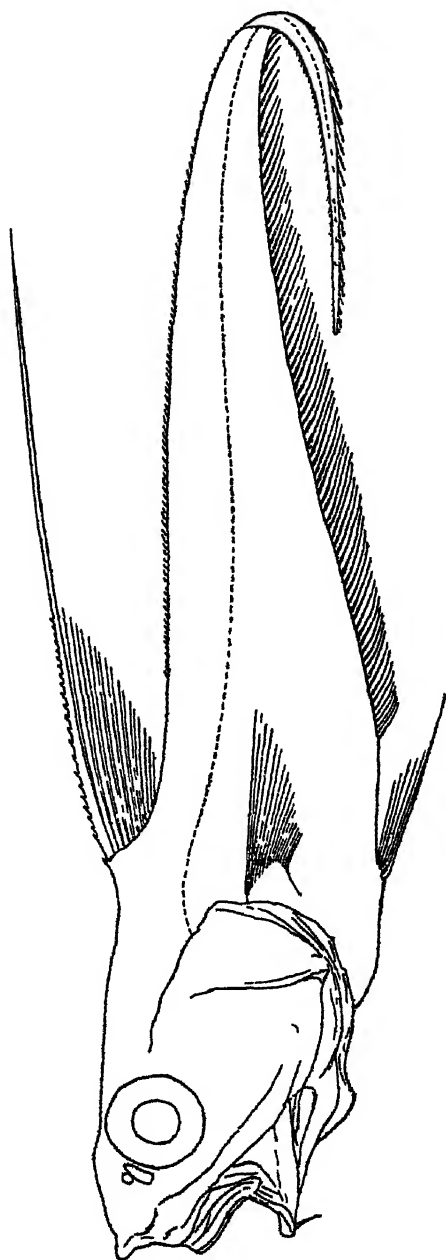
The ovaries are of moderate size and quite smooth and homogeneous on section.

A transverse section of an ovary, magnified, shows an external investment, about 1·20 millim. thick, of compact fibrous tissue, in which numerous large blood-vessels are imbedded, giving off internally fine loosely woven dissepiments to carry small blood-vessels into the substance of the ovary, the developing ova in their follicles being clustered round these dissepiments like grapes on a bunch. There is thus, even at this early stage, almost no interfollicular stroma.

The ova in the sections examined vary in diameter from ·05 to ·5 millim., the most usual diameter being ·25 millim.

Such an ovum lies in a follicle which it completely fills. The wall of the follicle is formed by a few fine fibres of connective tissue lined internally by a layer of very small flattened hexagonal cells, which in transverse section look like

Fig.

*Macrurus macrolophus.*

cubes. The ovum is defined by an egg-membrane of some thickness, which often shows as a broad double-contoured wavy line. The contents of the ovum are granular, and, as seen in transverse section, the granules have a tendency, best marked in the large ova, to arrange themselves in concentric circles round the nucleus, the innermost circle forming a fine darkly staining (carmine) circum-nuclear chain. The nucleus is a large circular or oval vesicle, sharply bounded by a very distinct nuclear membrane, and having a diameter nearly half that of the entire ovum. It contains from twenty to thirty, and sometimes even more, large vesicular nucleoli, deeply staining with carmine, which, in a view of a transverse section, have an inclination to fall in a ring round the periphery of the nucleus. In the largest ova the nucleoli are not so numerous and have no particular arrangement.

In the very smallest ova the follicular epithelium is not distinguishable.

10. *Macrurus Wood-Masoni*, Alcock.

Macrurus Wood-Masoni, Alcock, Ann. & Mag. Nat. Hist., Oct. 1890, p. 301, and Aug. 1891, p. 121.

In the original description of the type, which had suffered some denudation, it is stated that the lateral line runs $4\frac{1}{2}$ rows of scales beneath the first dorsal instead of $5\frac{1}{2}$, as all our later specimens show. In all these specimens, moreover, the terminal portion of the gut forms a wide pouch, which in one instance recalls the external appearance of the so-called "colon" of the Elasmobranchs.

Several specimens from Station 128, 902 fathoms, and Station 135, 559 fathoms.

BATHYGADUS, Günther.

11. *Bathygadus cottoides*, Günther?

? *Bathygadus cottoides*, Günther, 'Challenger' Deep-sea Fishes, p. 154, pl. xlii. fig. A.

I refer with some hesitation to this species a small specimen from Station 131, 410 fathoms, which agrees in most essential particulars with Dr. Günther's description. The only apparent divergences of the specimen are (1) that the eye is relatively larger, and (2) that the first dorsal ray is a little prolonged, both of which differences would become less and less marked with the advance of age.

Family Pleuronectidæ.

APHORISTIA, Kaup.

12. *Aphoristia Wood-Masoni*, Alcock.

Aphoristia Wood-Masoni, Alcock, Journ. As. Soc. Beng. vol. lviii. pt. ii., 1889, p. 204, pl. xvii. fig. 1 (outline).

Three fine specimens from Station 132, 475 fathoms.

The number of dorsal rays ranges from 90 to 98, and of anal from 78 to 84.

Order PHYSOSTOMI.

Family Sternoptychidæ.

GONOSTOMA, Rafinesque.

13. *Gonostoma elongatum*, Günther.

Gonostoma elongatum, Günther, 'Challenger' Deep-sea Fishes, p. 173, pl. xlv. fig. B; Alcock, Ann. & Mag. Nat. Hist., Aug. 1891, p. 127.

A fine female specimen, $7\frac{3}{4}$ inches long, was taken at Station 127, 1200 fathoms. From it we can confirm the observation that scales are absent in this species. From the fact that this individual was not only alive and active when taken from the trawl, but remained alive for about a quarter of an hour after it was brought on board, I think we may doubt whether it came from any great depth. No display of luminosity was observed, though it was watched for.

The ovaries in this specimen are long narrow tubes, extending throughout the length of the abdomen, in which the developing ova form a long string thrown into deep close pleats or laminæ. In a magnified transverse section of an ovary, stained with carmine, very little stroma is seen except where the ovarian blood-vessels course (longitudinally) along the tube; no follicular epithelium is visible; each ovum is bounded by a fine egg-membrane, within which the egg-substance forms a thick ring round the large nucleus, the egg-substance being granular and studded with large vesicles which do not take the stain; the nucleus is very definitely limited, although no membrane can be distinguished, and it stains so deeply that sometimes no further details can be made out, though generally from one to six even more deeply stained nucleoli are seen; its diameter is about half that of the whole ovum.

The stomach of *Gonostoma elongatum*, as investigated microscopically by transverse sections through its wall, has

the submucous coat most remarkably developed, and with a structure like that of the cortical substance of mammalian lymphatic gland; it consists of a very perfect and regular network of fine connective-tissue trabeculæ, the long narrow meshes of which are crowded with leucocytes; a dense layer of pigment bounds the submucosa externally.

CHAULIODUS, Bl. Schn.

14. *Chauliodus Sloanii*, Bl. Schn.

Several specimens were obtained in the Laccadive Sea.

The stomach of *Chauliodus*, like that of *Gonostoma*, is remarkable for the great development of its submucous coat, which, in transverse section under the microscope, is seen to be formed of a very regular and perfect connective-tissue network, of which the meshes are filled with deeply staining (carmine) leucocytes imbedded in a granular matrix—a structure not at all unlike that of the cortex of mammalian lymphatic gland. In many sections the larger septa, by whose regular ramifications the network is formed, pass straight through the muscular coat to the external fibrous coat of the viscus.

15. *Chauliodus pammelas*, sp. n.

B. 16. D. 6. A. 12. V. 7. P. 11–12.

Closely resembles *Chauliodus Sloanii*, from which it differs only in the following points:—(1) The body is much deeper, and has in life well-markedly convex dorsal and ventral profiles; (2) the eye is relatively much larger, its diameter being equal to the length of the snout measured to the extremity of the outstanding mandibular symphysis, or two sevenths the length of the entire head, or nearly two thirds of the length of the longest mandibular fang; (3) the skin is apparently naked, and though there are rhomboidal and hexagonal pits, these contain no silvery scale-like plates, but only a central “luminous” spot, and the entire body is covered in life with a thick sheet of transparent mucoid tissue traversed by capillary blood-vessels; (4) the ventral “luminous organs” are less numerous and very much smaller, and the suborbital organ, which in *C. Sloanii* is so conspicuous, is reduced to a minute point distinguishable only with a lens; (5) the first ray of the dorsal fin is relatively longer; (6) the body, fins, and iris are uniform jet-black.

A very fine specimen, 10 inches long, from Station 126, 1370 fathoms.

Family Scopelidæ.

HARPODON, Le Suer.

16. *Harpodon squamosus*, Alcock.

Harpodon squamosus, Alcock, Ann. & Mag. Nat. Hist., Aug. 1891, p. 127.

This interesting species seems characteristic of the Bay of Bengal, between 200 and 300 fathoms.

BATHYPTEROIS, Günther.

17. *Bathypterois insularum*, sp. n.

B. 13-14. D. 12-13. A. 10. P. 2/12-13. V. 9.
L. lat. 48-51. L. tr. 13.

Body elongate, its height a little more than half the length of the head, which is about one fourth of the total without the caudal. The snout, which has the typical duck-bill shape, is in length a little more than one third the length of the head. The very small eyes are not quite a snout-length apart. There is nothing peculiar about the mouth, but there are no teeth on the vomer. The branchial structures are identical with those of other species of the genus. The body and the head, except the jaws and snout, are covered with thin deciduous cycloid scales.

The dorsal fin begins half a snout-length behind the base of the ventrals, and the anal immediately behind the vertical through the last dorsal ray; there is a small adipose "fin" nearly midway between the dorsal and the base of the caudal. The two uppermost pectoral rays are intimately coherent in their basal half and reach at least as far as the adipose dorsal; the other pectoral rays, which are slender and rigid, reach at least as far as the vent. The ventral fins are very large, their two outermost rays, which are very stout and stiff, reach, when laid back, within a snout's length of the base of the caudal, their tips being filiform. The two or three lowermost rays of the forked caudal are prolonged, their length being at least one third that of the rest of the body.

Colour black; fins hyaline grey.

Length $5\frac{1}{2}$ inches.

Two adult females with gravid ovaries from Station 121, 1140 fathoms.

ALEPOCEPHALUS, Risso.

18. *Alepocephalus Blanfordii*, sp. n.

B. 6. D. 16. A. 17. P. 11. V. 6-7. L. lat. circa 70.
Pyloric cæca 12.

Length of head one third, height of body two elevenths, of the total without the caudal.

The length of the obtusely-pointed depressed snout is barely greater than the diameter of the huge orbit, or two sevenths of the length of the head.

The eyes are hardly half a diameter apart, with the large nostrils placed close together in front of their angle.

The mouth-cleft is almost horizontal, and the upper jaw, which reaches just beyond and rests upon the anterior border of the orbit, completely encloses the mandible on all sides; a row of fine teeth in each jaw and on each prominent palatine.

Gill-openings very wide, the gill-membranes entirely separate and not overlapping; the branchiostegal rays are but little concealed by the opercular bones, and the whole gill-cover is clothed by a continuation of the thick scaleless skin that covers the head; gill-rakers numerous, close-set, broadly lanceolate, acute; pseudobranchiæ large and coarse.

Body covered with thick deciduous cycloid scales; a scale from the abdomen is nearly 5.5 millim. in the horizontal and 5 millim. in the vertical diameter. The dorsal and anal fins, which are similar in form, equal in extent, and opposite, lie well within the posterior third of the body (measured without the caudal); the caudal is deeply forked, with many rudimentary rays at its base. The ventrals arise almost in the middle of the body, nearer to the anal than to the pectorals.

Stomach siphonal; a row of fourteen very large and long pyloric cæca embraces its pyloric moiety; the intestine, which when unravelled is about twice the entire length of the fish, is arranged as in *Alepocephalus bicolor* (Ann. & Mag. Nat. Hist., Aug. 1891, p. 134), but the wall of the coiled up small intestine is much thicker, and the straight hinder gut is held by a stout mesentery.

Colour: head and fins black; body lavender-grey.

A fine male, a little over 14 inches long, from Station 128, 902 fathoms.

The straight large gut in this species, as in *Alepocephalus bicolor*, is remarkable for the great thickness of its wall and for its contracted lumen; only in the present case, although the circular muscular coat is conspicuously thick, it is not

this but the highly glandular mucous coat that contributes most to the thickness of the wall. The great development of the glands of the mucosa, which are compact little branching follicles, is in marked contrast to *A. bicolor*, where the mucous membrane consists of simple columnar epithelium. The loose submucous coat is honeycombed with (lymphatic?) channels and crowded with leucocytes; but the large pigmented granular corpuscles which were so numerous in *A. bicolor* are here few in number.

The small intestine at its duodenal end and the pyloric cæca appear, in transverse sections, to be identical in structure. In both the mucous membrane is thrown into apparently permanent longitudinal folds, and contains in its depth a regular series of glands formed by a cluster of loculi opening into the bottom of a long vestibule which would serve as a duct. Microscopic cylinders of glandular substance, which in stained sections has exactly the appearance of mammalian pancreas, run in the mesentery, parallel with the pyloric cæca and in contact with them.

19. *Alepocephalus edentulus*, sp. n. (Pl. XVIII. fig. 2.)

B. 6. D. 29. A. 35. V. 6. P. 9. L. lat. circa 50.
L. tr. 15.

The length of the head is a little more than one fourth, and the height of the much compressed body nearly one fifth, of the total with the caudal included. The blunt snout is barely equal in length either to the width of the interorbital space or to the diameter of the eye, which is very nearly two ninths the length of the head. The mouth-cleft is almost horizontal, the jaws are even anteriorly, and the maxilla reaches considerably behind the vertical through the centre of the eye. Minute teeth occur in a row in the premaxillæ and mandibles, and there are a few inconspicuous and deciduous teeth on the prominent edges of the palatines only.

Gill-openings very wide, the gill-membranes being attached to the isthmus only quite anteriorly; gill-rakers conspicuous on all the branchial arches, and, to the number of about twelve in the middle of the first arch, long and setaceous; pseudo-branchiæ small. Head covered with a velvety scaleless skin; body with scales that are so deciduous as to have entirely disappeared, leaving only imprints.

The long anal fin begins an eye-length behind the middle of the body, measured without the caudal, and the shorter dorsal arises in the vertical through the sixth or seventh anal

ray; the caudal is completely divided down to its base into two long feathery lobes. The small ventrals, which arise midway between the base of the pectoral and the origin of the anal, reach rather more than halfway to the latter point.

Stomach siphonal; a row of four stout pyloric cæca; intestine slightly coiled, with its terminal end enlarged and thick-walled.

Colours: head and eyes jet-black; body and fins greyish black.

A single specimen (a mature male), nearly 7 inches long, from Station 132, 475 fathoms.

XENODERMICHTHYS, Günther.

20. *Xenodermichthys Guentheri*, sp. n. (Pl. XVIII. fig. 3.)

B. 6. D. circa 15. A. circa 14. V. 6? P. 5?

Body elongate, compressed, covered with a thick scaleless, longitudinally-wrinkled, black skin, in which scattered granular yellowish-coloured nodules are imbedded. The dorsal and anal profiles are symmetrically similar in life. The length of the head is slightly over two sevenths and the height of the body immediately behind the gill-opening slightly under one sixth of the total without the caudal.

The obtuse snout, surmounted by an acutely-pointed tubercle which projects from the prominent symphysis of the lower jaw, is not quite equal in length to the diameter of the circular eye. The eyes, which in life encroach upon the dorsal profile, measure between one fourth and two sevenths of the length of the head, and are about two thirds of a diameter apart.

The mouth-cleft is oblique, and the jaws are even in front, except for the symphysial tubercle on the mandible. The premaxillæ, which form on each side nearly one half the extent of the margin of the upper jaw, are armed with a row of minute close-set teeth, as are also the maxillæ, which have the typical Alepocephaloid structure and which reach to the vertical through the posterior border of the orbit, and the broad scapula-shaped mandible; no teeth on the palatines or vomer.

The gill-cleft is extremely wide, extending forwards almost to the mandibular symphysis and upwards almost to the post-temporal region; the opercle appears to be perfect, and, together with the branchiostegal rays, is enveloped in a thick membranous skin, as in *Alepocephalus*; four gills, with

numerous long close-set gill-rakers on the first arch; pseudo-branchiæ present.

No lateral line can be distinguished.

The dorsal and anal fins, which are equal, opposite, and similar, lie in the posterior third of the body, and approach within an eye-length of the long series of rudimentary rays that form the base of the deep-forked caudal. The ventrals lie well within the posterior half of the body, and the pectorals arise on the ventral profile, almost in the same horizontal line with the ventrals.

The stomach is siphonal and its pyloric end is embraced by a row of seven or eight cæcal appendages, the posterior six of which are relatively enormous; the intestine has an anterior much coiled portion and a hinder portion which passes perfectly straight backwards, much as in *Alepocephalus bicolor* and *A. Blanfordii*, to its orifice just in advance of the posterior third of the body.

Colour uniform jet-black.

One specimen, a mature female about 6 inches long, from Station 133, 678 fathoms.

The ovaries are distended with ova and terminate in a short, broad, straight oviduct, which opens by a broad pore behind the vent. The ova are of two sizes, some few being about as big as a pin's head, but the great majority being between 2 and 3 millimetres in diameter—a size truly enormous for such a small fish.

Five of the larger eggs were examined microscopically, and in every instance the large vesicular nucleus, with its large vesicular nucleolus, was found to lie, surrounded by a

Fig. 2.



Segment of the animal pole of an ovum of *Xenodermichthys Guentheri*, $\times 42$, showing the germinal disk with its large vesicular nucleus lying upon, and quite isolated from, the granular yolk.

thin but extended envelope of clear protoplasm, quite outside the granular mass of yolk, at one pole of the egg. In one case a linear series of such large nucleated vesicles (blastomeres?) was found lying imbedded in a thin disk of protoplasm at one pole, just as if the segmentation of the fertilized

ovum had begun. The nucleus, in short, with the clear protoplasm that surrounds it, forms a germinal disk lying upon but quite separate from the yolk, as has already been observed in many other Teleostean ova, and as has been commented upon by Mr. E. E. Prince in a paper upon "The Significance of the Yolk in the Eggs of Osseous Fishes" (Ann. & Mag. Nat. Hist., July 1887, pp. 1-8, pl. ii.), in which will be found numerous references to the work of previous observers.

In general external form *Xenodermichthys Guentheri* is not at all unlike *Xenodermichthys socialis*, Vaillant (Expéd. Sci. du 'Travailleur' et du 'Talisman,' Poiss. pp. 162-165, pl. xiii. fig. 1). Its form, too, strongly reminds one of certain Sternoptychoid types, e. g. *Gonostoma*, and even more, as Dr. Günther has already remarked of the type of this genus, of some of the Stomiidæ.

The details of its internal (visceral) structure repeat remarkably what I have myself observed in several Alepocephaloids, namely *Alepocephalus*, *Bathytroctes*, and *Narceus*.

LEPTODERMA, Vaillant.

21. *Leptoderma macrops*, Vaillant.

Leptoderma macrops, Vaillant, Expéd. Sci. du 'Travailleur' et du 'Talisman,' Poiss. p. 166, pl. xiii. fig. 2.

A magnificent quite perfect specimen, $8\frac{3}{4}$ inches long, from Station 134, 753 fathoms.

Over the intensely black cutis there stretches, from the tip of the snout to the tip of the tail and investing all the fins, a thick velvety opaline-grey epidermis, which much resembles that covering the head of *Aulastomatomorpha* (Ann. & Mag. Nat. Hist., Oct. 1890, p. 307, and Jan. 1891, p. 10). It appears probable that this epidermis is luminous in function, for when the fish was removed, freshly dead, from the trawl, and put into a pail of muddy sea-water under shade, its form could be distinctly made out glimmering, ghost-like, at the bottom of the pail. In the fresh state the epidermis is freely movable over the black skin beneath, but in spirit it contracts and becomes firmly adherent to the underlying tissues. Examined under the microscope nothing further can be seen than branched black and reddish-yellow pigment-cells.

There is a distinct lateral line, consisting of a single row of large pores, extending from the occiput to the base of the caudal.

The attenuated caudal is forked.

Small pseudobranchiæ consisting of three or four pinnules are present.

Family Halosauridæ.

HALOSAURUS, Johnson.

22. *Halosaurus parvipennis*, sp. n.

B. 13. D. 9. P. 12-13. V. 1/9. L. tr. $\frac{10}{5}$.

The length of the head is a little over one eighth of the total, or about two fifths the length of the rest of the trunk.

The length of the snout, of which nearly half is preoral, is two fifths that of the head, or equal to that of the postocular portion of the head. The eyes are separated by one fourth of a diameter only, their diameter being one half the length of the snout. The weak maxillary does not quite reach to the vertical through the anterior border of the orbit. Villiform teeth in bands in the jaws and palatines and in a narrowed band on the pterygoids.

Gill-rakers distant, short.

The dorsal fin arises from a scaly base about an eye-length behind the ventrals, which arise, also from scaly bases, a head-length and a quarter behind the gill-opening; about half a head-length behind the dorsal fin is an erectile scale as long as the eye. The weak, narrow, pointed pectorals are but little longer than the snout.

The scales of the lateral line are much more adherent than those of the rest of the body, though but little larger.

There are eight or nine small pyloric appendages in a row embracing the ascending limb of the siphonal stomach.

Colours: light sepia-brown, fins darker; opercles silvery; throat and branchiostegal membranes black.

A female, about 15 inches long, with gravid ovaries, from Station 122, 865 to 880 fathoms.

Family Murænidæ.

CONGROMURÆNA, Kaup.

23. *Congromuræna longicauda*, Alcock.

Congromuræna longicauda, Alcock, Ann. & Mag. Nat. Hist., Dec. 1889, p. 455.

This species seems to be characteristic of the Bay of Bengal between 200 and 300 fathoms.

UROCONGER, Kaup.

24. *Uroconger vicinus*, Vaillant.

Uroconger vicinus, Vaillant, Expéd. Sci. du 'Travailleur' et du 'Talisman,' Poiss. p. 80, pl. vi. fig. 1.

A large female, 25 inches long, with gravid ovaries, from Station 132, 475 fathoms.

The stomach in this specimen has a large cæcum, a much constricted pylorus, and a mucous membrane of two entirely different kinds, that in the anterior half being of an almost horny hardness, while that in the posterior half is soft and glandular.

In vertical longitudinal sections of the stomach-wall, carried through the abrupt line of demarcation between the two differing regions of mucous membrane, examined under the microscope, the following structure is seen:—

(1) *Common to both regions of the stomach*; (a) an external thin fibrous coat, one fortieth to one sixth of a millimetre thick, with many longitudinal bundles of muscular fibres and large blood-vessels; (b) a very compact thin coat of transverse muscular fibres, about one eighth of a millimetre thick; (c) another very compact layer of longitudinal muscular fibres, about one seventh of a millimetre thick; (d) a very thick ($\frac{3}{4}$ –1½ millimetre) submucous coat made up of a loose mesh-work of branching and anastomosing small-nucleated cells, the meshes being filled with lymphoid cells; this coat also contains many blood-vessels, which frequently traverse in their course large, compact, sharply-circumscribed nodules of lymphoid tissue, and a great many branching pigment-cells.

(2) *The mucous membrane of the anterior part*, which is about one eighth of a millimetre thick, appears at first like a superficial layer of pure fibrous tissue; but good sections show that it consists of a stratified epithelium with its constituent cells compressed somewhat as in the horny layer of the human epidermis. These compressed (horny) cells, however, are not flattened into plates to form a smooth surface, but are angularly concreted to form a broken rough surface. Beneath the superficial horny layer are several rows of cells of which the granular protoplasm seems to be fused into a solid mass, leaving only the nuclei distinct; and beneath this again comes fibrous tissue gradually passing into the loose submucosa.

(3) *The boundary-line* between the anterior horny mucosa and the posterior soft mucosa is very abrupt, and in every section there is seen a conspicuous thickening of the sub-

mucous coat at the expense of both the mucous and the muscular coats. The mucous coat is made up of the compact ramifications of an acino-tubular gland lined with granular, large-nucleated, cubical epithelium.

(4) *The mucous membrane of the posterior part*, which is rather over one fourth of a millimetre thick, is formed entirely of long tubular glands packed close together, side by side, at right angles to the surface. These glands, which much resemble mammalian gastric glands, are lined with a granular cubical epithelium having large prominent vesicular nuclei; they have broadish mouths, and in their deepest third they end by subdividing into two or three long sinuous branches, which lie in a plane parallel to that of the rest of the gland.

COLOCONGER, Alcock.

25. *Coloconger raniceps*, Alcock.

Coloconger raniceps, Alcock, Ann. & Mag. Nat. Hist., Dec. 1889, p. 456.

This species, like the next mentioned, seems to be characteristic of the Bay of Bengal between 200 and 400 fathoms, occurring in almost every haul.

NETTASTOMA, Rafinesque.

26. *Nettastoma tenuiola*, Alcock.

Nettastoma tenuiola, Alcock, Ann. & Mag. Nat. Hist., August 1891, p. 135.

I leave this species for the present in the genus *Nettastoma*. The tissues are very delicate, and though in some specimens the air-bladder is very distinct, in others it is hard to distinguish.

GAVALICEPS, Wood-Mason (MS.).

27. *Gavialiceps microps*, Alcock.

Gavialiceps microps, Alcock, Ann. & Mag. Nat. Hist., Dec. 1889, p. 461.

Two good specimens were obtained, one, 15 inches long, from Station 126, 1370 fathoms, the other, 13 inches long, from Station 128, 902 fathoms.

From an examination of these specimens in the fresh state, the following remarks must be added to the description of the mutilated and distorted (type) spirit-specimen:—

The long lash-like tail is between two and a half and two

and three quarter times the length of the combined head and trunk. The head, about half of which is formed by the long needle-like beak, is at least twice the length of the trunk proper; its posterior half is broad, deep, and subquadrangular. Eyes minute, subcutaneous, without any orbital fold. The maxillary teeth are arranged in a single row, and diminish in size but increase in number from behind forwards: the vomerine teeth posteriorly are long and sharp and are disposed in a long, close-set, comb-like series; anteriorly they form a fine rasp-like band: in the mandible a row of large distant needle-like teeth stands up from an uneven band of small denticles. Gill-openings close together, wide. The scaleless integument is thin and deciduous and thickly enveloped in mucus; no lateral line is apparent. The dorsal fin is feebly developed, and, indeed, hardly distinguishable. The pectoral fin is represented by an inconspicuous clavicular knob, without any rays.

The abdominal cavity extends at least halfway along the tail. The siphonal stomach, which has its pyloric end long, tapering, and much constricted, leads into a widely expanded duodenum, which, in the single specimen dissected, is furnished with a small diverticulum near the pylorus.

Colour uniform black, with a silvery sheen on the head.

This species is perhaps identical with *Nemichthys infans*, Vaillant (nec Günther), described and figured in Expéd. Sci. du 'Travailleur' et du 'Talisman,' Poiss. pp. 93 and 94, pl. vii. fig. 1, and there only doubtfully referred to Dr. Günther's type.

EXPLANATION OF PLATE XVIII.

Fig. 1. *Hepthocara sinum*, sp. n.

Fig. 2. *Alepocephalus edentulus*, sp. n.

Fig. 3. *Xenodermichthys Guentheri*, sp. n.

XLI.—*On the Origin and Development of the Mammalian Phylum.* By Dr. W. KÜKENTHAL*.

[An Address delivered on May 28, 1892, in the Aula of the University of Jena, in accordance with the provisions of the Paul von Ritter foundation for phylogenetic zoology.]

OWING to the great division of labour which has taken place in our science, compelling the investigator to occupy himself with individual problems, it is well that we, for once allowing

* Translated from the 'Biologisches Centralblatt,' xii. Bd. no. 13 (15th July, 1892), pp. 400-413.

our gaze to range further afield, should consider the relation of the separate contribution to the great whole, and from these general considerations should derive new ideas, or in some sort form plans, to guide us in our future work. It often happens that these ideas are widely different from that which one day appears as the result of laborious individual investigation in the same direction. If, however, we are justly conscious of this difference, we may well venture to give utterance at some time to such ideas, especially if, as on this annually recurring occasion, we are not in a position always to adduce verified results of our own original work, such as might engage the attention of a larger circle of listeners.

From this point of view I would ask you to consider my deductions on the subject of the Origin and Development of the Mammalian Phylum.

Of all Vertebrates, Mammals are the last to appear upon the earth; we find their earliest remains scantily represented in Triassic formations. While they very soon secured the mastery for themselves, so that we may designate our geological period as that of the Mammals, before their appearance the phylum of the Sauropsida was predominant. It is therefore quite natural to commence with the consideration of the latter if we would make a closer acquaintance with the question of the origin of Mammals.

We can gain no idea of the extraordinary wealth of forms in the reptilian class by considering the lizards, snakes, chelonians, and crocodiles which are at present in existence. These are merely the last miserable shoots of a once far-spreading tree, which embraced more than double the number of orders; we can gain no comprehensive view of them until we examine the remains which the strata of the earth have preserved for us. On the basis of the palæontological discoveries which multiply from year to year, we are enabled to trace the phylogeny of the reptiles, at least in its main outlines, with tolerable certainty.

The Reptiles, which did not appear on our earth until after the Fishes and Amphibia, have their earliest known representatives in the Permian formation, which belongs to the Palæozoic period. The Progonosauria, as they are called, are types which have as yet undergone but little specialization and combine in their organization the characteristics of all other orders of reptiles. Like a relic from remote antiquity, a descendant of these old forms projects into the present, represented by the genus *Hatteria*, which occurs only in New Zealand.

Almost simultaneously with the Progonosauria, and allied

to them in its earliest representatives, a second order appeared, that of the Theromorpha, which exhibits an extraordinarily many-sided development, and to which we have to devote closer attention. Likewise referable to the Progonosauria are the two orders Sauropterygia and Ichthyosauria, which enjoyed a pelagic existence upon the open sea and have undergone profound transformations in their structure, quite analogous to those which at a later epoch of the earth's history were experienced by the whales among the mammals. Very old also is the order of the Crocodilia, a branch of which has been preserved until the present time. In consequence of the palæontological facts their phylogeny is considered to be very well understood. The earliest crocodiles are Triassic; then forms greatly changed in aspect reappear in the uppermost Jurassic formation; these are traceable through all subsequent strata up to the present time. Now it is highly instructive to see how incomplete are even the best palæontological records, for, on the basis of embryological investigations upon crocodiles, I am driven to conclude that their ancestors were at a certain time pelagic animals * with corresponding characteristic morphological peculiarities, and only gradually developed into the littoral and fluviatile creatures such as we find them to-day. Palæontology, however, has no knowledge of such pelagic ancestors; its attention is first directed thereto by means of embryology, and it is to be hoped that we shall one day succeed in finding remains of the supposed ancestors in the strata which precede the uppermost Jurassic series. With the oldest crocodiles as well as the Progonosauria (Rhynchocephala) there is connected an order which excites general interest owing to the fact that it contains the largest terrestrial forms that the earth has ever produced. The length of the American *Atlantosaurus*, for instance, amounted to 115 feet, and its height to 30 feet, while its thigh was more than 6 feet long, and at its upper end exceeded 2 feet in diameter. Since these animals employed exclusively the hind legs for walking, a transformation of the hinder extremities, as also of the pelvis, was produced owing to the transference of the weight of the body to them, just as we see is the case in the birds in consequence of the same physiological cause. In spite of the fact that we may not at once utilize such resemblances for the purpose of establishing a phylogenetic connexion between the two, it is nevertheless conceivable that Dinosauria and birds may have

* In a paper which is at present in the press I have endeavoured to prove this assertion by means of the embryology of the skeleton of the hand.

common ancestors. In any case the birds have nothing to do with the order of the flying reptiles to which the remarkable *Pterodactylus* belongs. The origin of the Pterosauria is as yet by no means elucidated. While the Chelonians are a strongly specialized branch, which is perhaps to be derived from a group of the Theromorpha, the Lacertilia have their root in the primeval Rhynchocephala. From them there branched off during the Cretaceous period the pelagic Pythonomorpha, which soon became extinct again, as also the snakes, which are still in existence.

Having thus given a brief outline of the phylogeny of the Reptiles as it is now pretty generally accepted, we must now proceed to inquire from which of their orders the phylum of the Mammalia can have sprung. To this question an answer has been given to the effect that the already-mentioned Theromorpha are regarded as ancestors of the Mammalia, since they exhibit the greatest similarity to them. As a matter of fact a comparison of the skeletons, according to which alone we can proceed, since no other remains have come down to us, exhibits a considerable number of similar characters in the two groups*.

Especially striking is the oft-quoted resemblance in the differentiation of the dentition. As among the Mammalia, so also in the Theromorpha, we find a morphological difference within the dental series; here also we may speak of incisors, canines, and molars, in contradistinction to other reptiles, in which only uniformly conical teeth exist in the jaw. It therefore appears to be imperative that we should undertake a closer consideration of the Theromorphous dentition.

Of the four suborders of the Theromorpha the greatest number of resemblances in dentition to other reptiles is exhibited by the Pareiasauria. In these creatures all the teeth, the number of which was fairly large (seventy-six in *Pareiasaurus bombidens*), were devoted to tolerably similar functions, and accordingly exhibit only small differences in their structure. In all the genera described by Owen (*Tapinocephalus*, *Pareiasaurus*, and *Anthodon*) distinct rudiments of successional teeth are present internally to the dental series.

Far greater differentiation is found in the dentition of the Theriodontia, whose teeth are constructed according to the carnivorous type. No trace of rudiments of successional teeth has been found in any of these predaceous reptiles.

The two other suborders have a dentition which is very

* Cope, "The Relations between the Theromorphous Reptiles and the Monotrema Mammalia," Proc. Amer. Assoc. for the Advancement of Science, vol. xxiii. (1885).

divergent in form; the Anomodontia possessed only a pair of powerful tusks (similar to those of the walrus) in the upper jaw, or were completely edentulous.

The Placodontia, whose right to be included in the order of the Theromorpha is, however, not certain, were still more singularly equipped, since they possessed incisors in front, and posteriorly rounded molars in the upper jaw and large flattened teeth in the mandible, while in addition to these the palate was covered with large flattened teeth. A precisely similar dentition is found, moreover, in fossil fishes—the Pycnodontia—to which these reptiles were at first assigned.

If we disregard for the moment the two last-mentioned groups, and devote our attention to the Pareiasauria and Theriodontia, we are especially struck by the fact that here we are not confronted, as in the case of other reptiles, with a succession of several dentitions, which are capable of excellent preservation in fossils (compare, for instance, the figure of *Diplodocus longus*, Marsh, in Zittel's 'Handbuch der Paläontologie,' iii. Bd. p. 716, where no fewer than six consecutive successional teeth are developed); but that in these animals there takes place only a single succession or none at all—the latter being the case in the most specialized dentitions. Within the order of the Theromorpha therefore the formation of successional teeth is lost as the individual teeth become more highly specialized.

We meet with perfectly analogous conditions once more in the mammals*, for in the marsupials also the second dentition is suppressed with the exception of one premolar, although it is present in the form of a rudiment (the dental fold); here also the teeth of the first dentition, which alone arrives at development, are highly specialized.

A very material advance in the completion of the dentition is not exhibited until we come to the placental mammals, in which (with a few exceptions, which will be dealt with directly) highly specialized teeth of the second as well as of the first dentition are developed. With this we have attained the highest known stage of dental development. As regards the exceptions, the toothed whales and the edentates, I have already shown in my address delivered on this occasion last year, that the condition of their dentition is a secondary one, since the primitive specialization of their teeth appeared no longer necessary, in consequence of diminution of their diffe-

* *Vide* my papers in the 'Anatomischer Anzeiger,' 1891, pp. 364 and 658 [Ann. & Mag. Nat. Hist. ser. 6, vol. ix. pp. 279-294], as well as my address delivered on May 30, 1891, "Ueber den Ursprung und die Entwicklung der Säugetierzähne," Jenaische Zeitschrift, 1892.

rent functions, and the second dentition which was originally present is still developed rudimentarily in the embryo, but no longer cuts the gum. The similarity between the dentition of these two orders of placental mammals and that of the marsupials is therefore due to the persistence of the first dentition; but the great difference is that in the case of the marsupials the second dentition does not appear, because the teeth of the first have become highly specialized, while in that of the edentates and toothed whales the same phenomenon is occasioned by a degeneration produced by a diminution of the functions.

If we therefore consider impartially the groups which we have been discussing, not allowing ourselves to be prejudiced by phylogenetic hypotheses, we see that in Theromorpha, marsupials, and placental mammals the original condition of the dentition was that of polyphyodontism in the case of the first-mentioned group and diphyodontism in that of the two latter. But we further find that in consequence of the same cause, specialization of the individual teeth, in the Theromorpha all dentitions except the first were suppressed, while in the marsupials at least one tooth of the second dentition became functional; but in the placental mammals, in spite of the specialization, both dentitions appeared.

In the three groups of the Theromorpha, Marsupialia, and Placentalia we thus have three stages in dental development which differ in height and which have been developed according to the same laws, but from a successively higher basis.

The impression is produced upon us that the height of the development of the dentition always corresponds to the degree to which the organization of the groups of animals in question has advanced, an idea which is rendered perfectly probable owing to the principle of correlation of organs. This is as much as to say that the similarities which we find in the three differently advanced forms of dentition depend upon phenomena due to convergence, and cannot be employed to set up phylogenetic connexions. As a matter of fact we see that the dentition of the Theriodontia really resembles that of the predaceous Marsupialia and predaceous Placentalia, but not that of the lowest mammals, with which we are acquainted owing to the discoveries of palæontology, and to the consideration of which we will now proceed.

The oldest known remains of mammals come from the Trias and exhibit a wide geographical distribution, since isolated teeth or incomplete skulls have been found in Swabia, in North Carolina, in Basutoland, and at the Cape. This by itself is an argument in favour of greater antiquity for the mamma-

lian phylum, and renders it probable that the group had its origin in the Palæozoic period. In the examination of the Triassic mammals we have to rely almost exclusively on the teeth, the structure of which is extremely peculiar. It is true that in many respects they still have a reptilian character, which is especially visible in the small development of the root; but not only do we find a specialization of the dentition into incisors, canine, and molars, but the structure of the latter is in the highest degree remarkable, for each molar is composed of numerous cusps, which are arranged in two or three rows and are separated by longitudinal furrows. In consequence of this the name "Multituberculata" has been bestowed upon these ancient mammals.

A year ago I advanced the theory that the molars of the *Mammalia* are to be regarded as having arisen owing to the fusing together into groups of original conical reptilian teeth*, and this conception was chiefly derived from the observation of the contrary process, since in whalebone whales a large number of teeth with single tips is produced from original multicuspid molars through fission, which sets in in the course of the development. Now in the molars of the *Multituberculata* I find an important argument in favour of my view. I regard a molar of one of these mammals as having arisen through the fusion of a number of conical reptilian teeth, and, simultaneously with this, a fusion of the corresponding successional teeth with one another and the first series. In the case of the multituberculate molars, which are provided with three longitudinal rows of cusps, a fusion of corresponding teeth of the third dentition is superadded. The fusion of teeth belonging to successive dentitions is in itself in no way wonderful. The difference in the time of appearance is indeed an absolutely secondary phenomenon, and in the highest

* This idea, which was suggested by me with the necessary reserve, was rejected as infelicitous by O. Thomas ("Notes on Dr. W. Kükenenthal's Discoveries in Mammalian Dentition," *Ann. & Mag. Nat. Hist.* ser. 6, vol. ix. no. 52, p. 312), who, in doing so, relies chiefly upon the fact that the number of teeth in the primitive *Mammalia* is greater than that which is found in many *Anomodontia*, the most mammalian of the *Reptilia*. "This fact is alone sufficient to discredit Dr. Kükenenthal's theory." Although now as ever I am far from regarding my idea as a thoroughly substantiated theory, I would nevertheless here point out that after what I have stated above as to the position of the *Theromorpha* it is impossible for me to admit this objection. In an essay which has appeared during the printing of this paper ("Ueber die Entstehung der Formabänderung der menschlichen Molaren," *Anat. Anz.* June 3, 1892) Herr Röse adopts my conception, and designates it as his theory, without even mentioning me, although he is acquainted with my papers on this subject.

mammals also a fusion of the rudiments of both dentitions occurs in the formation of the true molars*.

If the multituberculate molars have arisen in this fashion, it follows that their number must be very small, since each tooth corresponds to a whole series of simple reptilian teeth. As a matter of fact we find in each half of the jaw only one or two molars, while the number of the similarly constructed premolars is at the most four, but usually less. It is difficult to understand how the process of fusion has taken place, since the shortening of the long jaws of the reptiles to the short ones of the mammals is not of itself a sufficient explanation; nevertheless the fusion of teeth in the vertebrates is a fact, and consequently my view is in no way opposed to processes of tooth-formation in lower Vertebrata.

If the mammalian molars have really arisen as I have suggested, the hypothesis which is at present generally accepted, and has been especially developed by Cope and Osborn, is consequently invalidated up to a certain point. Starting from the simple conical reptilian tooth, such as, according to these authors, has been preserved in the dolphin†, the development of the mammalian molars is supposed to have taken place by the outgrowth of a small cusp in front and behind. The difficulty of conceiving the mechanical process of such an outgrowth has already been touched upon by Fleischmann‡, since Cope's attempt to explain the development of these cusps, as being due to the increased supply of formative material, is an absolute failure. But the difficulty is abolished if the triconodont and tritubercular teeth are regarded with me merely as constituting a special division of the multitubercular teeth, and therefore as structures which

* This view also, which I expressed on the basis of my investigations, is regarded by Thomas (*loc. cit.* p. 311) as an "extraordinary and, to all appearance, most unlikely theory." Without here entering into further explanations, I will merely refer the reader to p. 231 of Hertwig's 'Lehrbuch der Entwicklungsgeschichte des Menschen und der Säugetiere,' where it is stated:—"In addition to this the enamel organs of the posterior or true molars, which are subject to no change, but of which the rudiments are altogether only formed once, are developed at the right and left end of the two epithelial folds." These two epithelial folds are, however, nothing else than the earliest rudiments of the enamel organs of the first and second dentition, which in the case of the premolars remain separate.

† Thomas is in error in thinking that this view is only shared by Baume; *vide, e. g.*, Schlosser, "Die Differenzierung des Säugetiergebisses," *Biol. Centralbl.* 1891, p. 238.

‡ Fleischmann, "Die Grundform der Backzähne bei Säugetieren und die Homologie der einzelnen Höcker," *Sitzungsber. der k. Akad. Berlin*, 1891.

have originally arisen through fusion. The further hypotheses of the American palæontologists, in connexion with the tritubercular type of tooth, are not affected by this.

A radical distinction would consequently have to be drawn between the molars of the reptiles and those of the mammals. The teeth of the theromorphous reptiles, whose molars were already described by Owen in most cases as simple conical teeth, are only homologous to a simple reptilian tooth, or else, as in the case of the Theriodontia, a fusion takes place. This fusion, however, always affects the individual tooth alone, and the rudiment of its corresponding successional tooth, which is contained in the dental fold. (My view is clearly illustrated by the figure of the skull of *Empedocles molaris*, Cope, given by Zittel in his 'Handbuch der Paläontologie,' Bd. iii. p. 581.) The molars of the Mammalia, on the other hand, represent much more complicated structures; they have arisen through the fusion of a larger or smaller number of conical reptilian teeth which lie one behind the other, and in addition to these there is usually added the corresponding series of teeth of the second and it may be of the third dentition. In this process the shortening of the jaws must have had an important mechanical effect.

I would further support my hypothesis by the following consideration, which also embraces the other classes of Vertebrata. *In the first place I lay down this principle for the development of the teeth within the entire vertebrate series, that the development of the dentition is primarily traceable to the fusion of individual teeth.*

The simple dentine tooth of the fishes is to be regarded as the primary element. Just as, according to O. Hertwig, the covering bones of the oral cavity have arisen through the growing together of the basal plates of these elementary structures, so also through fusion of the teeth themselves more complicated forms of teeth have been produced.

This process can be traced by means of comparative anatomy in the Selachians. Thus, for instance, *Cladodus*, one of the oldest forms of sharks, exhibits the following arrangement of teeth: on an elongated base a number of conical tips arise, of which the middle and the two outer ones are the longest (*vide* Zittel, Bd. iii. p. 67). The origin of this dental structure would be quite unintelligible if we would assume it to have arisen through gradual differentiation of a single tooth-tip; it appears, on the other hand, quite natural to suppose this formation to consist of a series of individual teeth fused together. The other forms of teeth then arose through the more and more intimate fusion of the

individual elements. This, however, by no means excludes the possibility of individual teeth increasing in size, even without fusion, in consequence of having an increased amount of work to do; only the teeth with a number of tips cannot be thus explained. I therefore consider the original single tooth of the fishes as a tooth of the first order, as opposed to the teeth of the second order, which have arisen through the fusion of several, as we already find them within the class of fishes. With this complication there naturally takes place a diminution in the number of dentitions of which rudiments are formed. In fishes tooth-change as a general rule is unlimited; it already ceases, however, within the limits of this class with the development of very large individual teeth, therefore with commencing specialization (*e. g.* in *Chimaera* or *Ceratodus*).

In reptiles also the number of dentitions is a limited one. If we would compare the individual tooth of a reptile with the teeth of fishes we should preferably select the teeth of the second order in the case of the latter. Like these many reptilian teeth also exhibit complications, which point to a fusion having formerly taken place (*e. g.* the teeth of *Scelidosaurus Harrisoni*, Owen [Zittel, Bd. iii. p. 741], or of *Anthodon* or *Galesaurus* among the Theromorphs).

Yet another fusion took place on the origin of the mammals from reptile-like ancestors. The mammalian molars are therefore teeth of the third order, which have arisen through fusion of reptilian teeth. The result of this process is seen most beautifully developed in the case of the Multituberculata, the oldest mammals which are as yet known.

A simple tooth of a fish and reptile and a mammalian molar are therefore not homologizable with one another; on the contrary, they represent three different stages of dental development proceeding from fusion. This at the same time gives us the simple mechanical cause of the gradual reduction of the dentitions.

The principle of fusion of teeth consequently explains the constant increasingly higher development of the dentition within the vertebrate series. A second principle, operating within each individual group, is that which modifies the teeth so as to make them as efficient as possible, and adapts them in accordance with the claims of function. Function depends upon the mode in which food is acquired; this, however, varies but little in the different classes of animals, and thus is explained the great similarity also which exists between the dentitions of many forms belonging to different classes of vertebrates, such as, for instance, is found in Theriodontia,

predaceous marsupials, and predaceous placental mammals. It consequently follows from my line of argument that a phylogenetic connexion between the forms in question on the basis of the dentition is absolutely inadmissible.

The question as to the origin of the Mammalia we now answer in the following way. The ancestors of the Mammalia were not theromorphous reptiles, as is usually supposed, but primeval forms (from which indeed the Theromorpha may likewise have originated) living during the Palæozoic period, with a but little specialized dentition, which still consisted of uniform conical teeth. From these there were developed in the first instance mammals with a multituberculate dentition.

Many suggestions may be made as to the causes which may have brought about the origin of the Mammalia. The statements of Haacke * on this point sound quite plausible. According to this writer the mammals, which are warm-blooded in contradistinction to the reptiles, which have an alternating temperature, can only have originated at a time when the temperature underwent an appreciable and permanent cooling; and it is stated that this probably took place during a cold period, which geologists term the Permian (?) Glacial epoch. With the acquisition of a higher temperature for the blood, the development of a bad conductor of heat, in the shape of the hairy coat †, became necessary; and to this was added the formation of sebaceous glands to grease the hairs, and sweat-glands to regulate the temperature of the body.

Moreover, in connexion with the lowering of the temperature came the incubation of the ova, for the young had now to be hatched by means of the mother's own bodily heat. In relation with this we have the formation and further development of the incubatory apparatus, such as we still see it to-day in the case of the oviparous Monotremata.

We now come to the second part of our subject, that of the development of the mammalian phylum. The existing mammals are divided into three subclasses—Monotremata, Marsupialia, and Placentalia. The bodily structure of the still oviparous Monotremata, although variously modified in consequence of special adaptation, exhibits such primitive

* Haacke, "Ueber die Entstehung des Säugetiers," Biol. Centralbl. 1889, p. 8.

† In a paper which will shortly be published, and which has been worked out under my direction, it will be proved by Herr Römer, one of my students, by means of embryological investigations, that the dermal armature of the armadillos is a secondary acquisition, and that in their original condition these animals were provided with a hairy coat.

characters that we must regard them as descendants of the most primitive mammals. Now, on the basis of our considerations on the dentition, we determined that the Multituberculata were the most primitive Mammalia; the Monotremata therefore must be the descendants of the old Multituberculata. This supposition recently received confirmation owing to the discovery that while the adults of both forms, *Platypus* and *Echidna*, are toothless, the young of the former possess two molars hidden beneath the flesh of the gum, which exhibit a distinctly multitubercular structure. The Monotremata therefore appear to be really a specialized lateral branch of the Multituberculata.

The representatives of the second subclass, the marsupials, branched off at a very early period from this ancient stem; their type of dentition is traceable to a modification of the multituberculate type. Their bodily structure exhibits in general a development occupying a position between Monotremata and Placentalia; and we regard them as an intermediate mammalian stage from which the placental mammals have been developed. According to many authors the several orders of placental mammals have sprung from the corresponding orders of marsupials, and the former are therefore polyphyletic in origin; according to others the subclass of the Placentalia originated from a more generalized marsupial type.

Let us now examine the evidence, which in any way goes to show that the placental mammals are to be derived from the marsupials. In the first place there are adduced general resemblances and the different degrees of development of the several organs. These arguments we can at once reject as untenable, for the different degree of the resemblance of the organs with those of the two other subclasses may be also explained, if we trace the placental mammals not to the marsupials, but directly to the monotremes. These resemblances would then be simply phenomena of convergence, arising in consequence of adaptation to a similar mode of life.

A more cogent argument for regarding the marsupials as the ancestors of the placental mammals would be the discovery of specific marsupial characters in the development of individuals belonging to the latter. Such a discovery is supposed to have been made in the finding of remains of the marsupial bones, which in the marsupials serve for the support of the pouch and are quite characteristic structures. Now, however, Wiedersheim*, the latest author on this

* Wiedersheim, "Die Phylogenie der Beuteltknochen. Eine entwicklungsgeschichtlich-vergleichend anatomische Studie," Zeitschrift für wissenschaftliche Zoologie, liii., Suppl., 1892.

subject, writes as follows as to the persistence of the marsupial bones in the placental mammals:—"I must here at once observe that I have been unable to discover these in any embryo—and I have examined representatives of all the chief groups—to say nothing of an adult animal." That which persists in the placental mammals is a girdle of cartilage, which in the amphibians and reptiles represents the formative material of the epipubis, and in the marsupials furnishes the marsupial bones which are homologous with this.

If, therefore, the arguments in favour of the derivation of the placental mammals from the marsupial are untenable, there are, on the other hand, others which tell directly against the theory. The most primitive condition of the brood-apparatus is represented by two so-called mammary pouches, as they are found in the *Echidna*; the brood-pouch is an acquisition which is to be derived from this, in that the edges of the mammary pouches become completely (temporarily in *Echidna*) or partially (in the marsupials) fused together.

Now the dermal pouches which occur in many ungulates have recently been identified by Klaatsch* as mammary pouches, which he regards as discarded mammary structures, while the remaining pairs of mammary pouches have become completely modified into teats. Klaatsch therefore considers it to be conceivable that the ungulates never passed through a marsupial stage, and at any rate concludes that the ungulates have never possessed a pouch-structure like the existing marsupials.

A further weighty objection is to be found in the constitution of the dentition. As I was the first to demonstrate, the dentition of the adult marsupials belongs to the first series, while that of the adult placental mammals represents the second set of teeth. This by itself is at once a deep-seated difference which prevents any homologization. Moreover the marsupial dentition exhibits a type which is firmly closed within itself and from which a further development appears impossible. Quite characteristic is the entrance of a premolar of the second series into the dentition, a peculiarity which has persisted from the Jurassic down to the recent forms.

To sum up shortly the results of these considerations, we find that tenable arguments for deriving the placental mammals from the marsupials do not exist, but that there are some that tell against such a process. We may well imagine that the placental mammals originated from the ancient

* Klaatsch, "Ueber Mammartaschen bei erwachsenen Huftieren," Morph. Jahrbuch, Bd. 18, Heft 2, p. 349.

mammalian stem, which still persists with least alteration in the monotremes, and that certain of their orders have acquired the placenta independently of one another*. The marsupials form a branch which runs parallel to the placental mammals, and likewise originated from the main stem. The resemblances within the individual orders of the two subclasses are merely instances of convergence.

It is not my intention to follow out the development of the mammalian phylum in detail, enticing though it would be to show how the hypotheses derived from the study of comparative anatomy and embryology are supported by the palæontological discoveries which are multiplied from year to year. It was rather my desire to bring forward certain problems which are connected with the investigation of the mammalian phylum, and to expose the methods by which work is now-a-days carried on.

Far from regarding the erection of a sort of picture-gallery of ancestors as the goal to which our science should aspire, we rather seek to obtain a clue to the complicated causes which have brought about the immense variety of animal forms. We would discover the laws which the organic world obeys.

At the same time, however, I would wish to combat the fundamental error of believing the problem of life to be solved, if we should succeed in recognizing the mechanical laws which have been active in the development and modification of organic bodies. The knowledge of the vital processes themselves is not in the least advanced thereby; with the same degree of justice we could, to use Bunge's simile, regard the movement of the leaves and twigs on the tree, which are tossed by the storm, as manifestations of life. What we are able to perceive is nothing else than the way in which living matter reacts upon forces coming from without. This task, which has been attacked in its full extent by the physiology of to-day, has recently been claimed by a number of, for the most part, junior investigators as the sole object to which biological science has to devote itself. While claiming to have discovered an absolutely new method of biological investigation, they believe that this mechanico-etiological method is the only way which we dare follow for the solution of biological questions, and that the "morphologico-historical" method, based upon the theory of descent and hitherto generally employed, must be abandoned.

* Marsh represents the same view of the question on the basis of his palæontological investigations; *vide* Marsh, "American Jurassic Mammals," *Amer. Journ. of Science*, vol. xxxiii, 1887.

Indeed, in one direction they even talk of the "futility of the theory of descent" !

How could this view have arisen? In the first place it is to be remarked that the so-called "morphologico-historical" method is an artificially constructed conception, which by no means coincides with the "phylogenetic" method, which is nevertheless said to be intended thereby. It is undoubtedly true that morphology has stood for a time in the foreground and has been almost exclusively employed in phylogenetic investigations. Since in addition to this isolated branches of morphology were applied more or less exclusively to the solution of phylogenetic problems, our science threatened to become shallow. I need but allude to the innumerable papers in the domain of embryology which apply their one-sided results to phylogenetic speculations. A deepening of our science can only set in when not only the three branches of morphology, comparative anatomy, embryology and palæontology, but also physiology, are simultaneously employed as roads to knowledge. The goal which we thus attain to is the comprehension of the position of each animal in nature, the determination of its relations to the surrounding organic and inorganic world, and the discovery of laws of constantly more general application which have governed the organic genesis. Now, as ever, the problem of life itself remains untouched by this method of investigation; in our studies we reckon with the living properties of an organic body as with a fact which we indeed have not explained, but which is none the less established.

The adherents of the new school, however, believe that they are able to conduct this latter problem to its final solution if they apply the method which they have chosen, of referring everything that happens in the animal body to physico-chemical laws. But every animal body is the result of two groups of forces, which form and transform it. The one is still unexplained, and was formerly termed vital force, the other is the totality of the physico-chemical forces of the outer world. In order to reach the goal which they are striving after, the representatives of the new school completely ignore the fact that in each organism, in each of its cells, processes take place which we term life and cannot explain.

Herein, therefore, lies the great error of the mechanico-etiological school, in believing that it is able to explain life itself, while, on the contrary, its final aim can only be to show how organic formations which are already in existence are subject to the physico-chemical forces just as much as the inorganic bodies. The new element which the mechanico-

etiological school brings with it is therefore false; the true portion of it has long been known as physiology.

In spite of this it is of great importance to lay especial emphasis upon it; it was able to render our historic method considerably more profound, and must become an integral part of phylogenetic investigation. To bring it into a mutually exclusive opposition to the historic method, as has been done, is without justification. Without the idea of descent the structure of an animal body cannot be understood. One example will suffice. In the whalebone whales teeth appear in the earliest embryonic period. These do not cut the gum, are entirely functionless, and after some time, still in the embryo, are completely absorbed. Now how can we succeed in understanding this phenomenon by means of the mechanico-etiological method? Is not our want of a cause satisfied to a certain extent if, on the basis of phylogenetic investigation, we are able to prove that the germs of these teeth are inherited from ancestors of the whalebone whales, in which the teeth were functional, while in the existing whales, in consequence of an altered mode of life, they are replaced by more practical organs in the shape of the whalebone?

In conclusion I would emphasize the fact that I too am convinced that the processes which are termed vital force obey the same laws which dominate the inorganic world. I too behold in the introduction of a vital force, which is to us obscure and mysterious, only an unnecessary addition, and consider the tracing of life to physico-chemical laws, although not as a fact that has been proved, nevertheless as a scientific postulate.

XLII.—*Additions to the Shell-Fauna of the Victoria Nyanza or Lake Oukéréwé.* By EDGAR A. SMITH.

SINCE the publication of my report on the shells of this lake in the 'Annals' for last August I have discovered that Dr. E. von Martens a month or two previously had described five species from the same locality, namely one species of *Limnæa*, a *Physa*, and three species of *Viviparus*. The *Physa* is the species which in his former paper (SB. Gesell. nat. Freund. Berlin, 1879, p. 103) he considered might possibly belong to *P. nyassana*, Smith.

The British Museum has recently obtained a small collection made by the Rev. E. Cyril Gordon at both the north and south shores of the lake. This series, consisting of eleven species, contains nine which are new to the Museum, four being also new to science. The finest species, belonging to the genus *Ampullaria*, hitherto unknown from the lake, is the largest of that group as yet recorded from the African continent, and the *Sphærium* represents a genus which, besides being sparingly represented in Africa, is also new to the lake.

In addition to the above species Mr. Gordon also obtained the *Ætheria elliptica* from the Nile at the Ripon Falls. This species was found at the southern part of Lake Victoria by the late Bishop Hannington.

I. *Additional Species described by Dr. E. von Martens.*

1. *Limnæa nyansæ*, Martens.

Limnæa nyansæ, Martens, SB. Gesell. nat. Freund. Berlin, 1892, no. 2, p. 16.

Hab. West shore at Bukoba and Towalio.

2. *Physa trigona*, Martens.

Physa trigona, Martens, l. c. p. 17.

Hab. Bukome in South-west Creek (*Martens*); North end (*Gordon*).

3. *Viviparus phthinotropis*, Martens.

Viviparus phthinotropis, Martens, l. c. p. 17.

Hab. Njamagolso, south-west part of lake.

This species may be the same as my *V. victoriæ*.

4. *Viviparus trochlearis*, Martens.

Viviparus trochlearis, Martens, l. c. p. 18.

Hab. Sirwa Island.

5. *Viviparus costulatus*, Martens.

Viviparus costulatus, Martens, l. c. p. 18.

Hab. Kassarasi Island.

II. *New Species discovered by Rev. E. Cyril Gordon.**Ampullaria nyanzæ.*

Testa maxima, globosa, late umbilicata, solida, ponderosa, epidermide olivaceo-fusca induta; anfractus 6, primi tres crosi, sequentes convexi, incrementi lineis obliquis medioeriter fortibus striisque spiralibus minutis confertissimis sculpti, ultimus infra periostracum zonis numerosis angustis obscuris pictus; apertura inverse auriformis, luteo-albida, zonis spiralibus purpureo-fuscis, præcipuo ad marginem conspicuis, obscure picta, longit. totius $\frac{5}{7}$ subæquans; peristoma haud incrassatum, intus plus minus flavescens, purpureo-fusco maculatum, margine columellari obliquo, medioeriter reflexo, superne flavo, infra purpureo-fusco tincto.

Alt. 115 millim., diam. maj. 108. min. 85; apertura 80 longa, 52 lata.

Hab. A creek, commonly called Jordan's Nullah, at the south end of the lake.

This species is the largest recorded from any part of Africa. *Ampullaria charmesiana*, Billotte *, is nearly as large, and occurs in the Nile above Gondokoro; that species, however, is longitudinally costulate, has a narrower aperture, and the peristome is strongly thickened within and tinted with orange. On the contrary, *A. nyanzæ* has a thin peristome without any thickening within, and is conspicuously blotched with purple-brown by the terminations of the spiral zones. The surface of this species is very minutely spirally striated, a feature also occurring in *A. speciosa*, another large form from eastern Africa. That species, like *A. charmesiana*, has an orange lip with an internal thickening. It has a more depressed spire and the whorls are more or less impressed or channelled above at the suture.

Reeves's figure of *A. erythrostoma* (Conch. Icon. pl. xiii. fig. 59), if the three apical whorls be concealed, gives a fair idea of the proportions of the present species.

Ampullaria Gordoni.

Testa globosa, anguste perforata, zonis numerosis angustis saturato fuscis epidermide olivacea subobscuratis cincta; anfractus 5, celeriter crescentes, medioeriter convexi, sutura lineari flava sejuncti, plus minus minute et spiraliter striati, ultimus magnus, incrementi lineis obliquis sculptus; apertura magna, longit. totius $\frac{4}{5}$ fere æquans, intus purpurea zonis externis indistincte notata;

* Bull. Soc. Mal. France, 1885, vol. ii. p. 106.

peristoma tenue, intus nigro-purpureum, inferne leviter effusum, ad columellam vix reflexum, marginibus callo plus minus atropurpureo junctis.

Alt. 54 millim., diam. maj. 52, min. 37: apertura 44 longa, 27 lata.

Hab. Victoria Nyanza (south end?).

The single shell which I have named after Mr. Gordon does not appear to be the young of *A. nyanzae*. It is much more narrowly umbilicated, has a shorter spire and a larger aperture. The latter is of a much darker colour, the columella and the inside of the outer lip are purplish black, and the external spiral narrow zones are more distinct.

Planorbis victorice.

Testa inferne late et profunde umbilicata, supra minus profunde et angustius excavata, mediocriter inflata, lineis incrementi obliquis striata, olivacea; anfractus 3-4, celeriter crescentes, ultimus superne et ad peripheriam rotundatus, infra circa umbilicum compresse angulatus vel carinatus, antice subdescendens; apertura mediocriter magna, fusca, superne lata, inferne angustata, recedens; peristoma (lateraliter visum) obliquum.

Diam. maj. 8 millim., min. 6, alt. 4.

Hab. North end of the lake.

This species apparently is distinct from *Pl. choanomphalus*, Martens, also from Lake Victoria. It has no upper or peripheral angle, and the lower side is more deeply umbilicated than the upper.

Sphærium nyanzae.

Testa rotunde ovata, solidiuscula, mediocriter globosa, straminea, umbones versus leviter erosa, subæquilateralis, striis concentricis tenuibus sculpta; latus anticum rotundatum, posticum paulo latius; umbones parum prominentes, obtusi, mediani: dentes cardinales mediocres, laterales validi; pagina interna albida.

Longit. 7 millim., alt. 6, diam. 4½.

Hab. North end of the lake.

This species is of rather solid texture, of a straw-colour, and only faintly striated. The lateral teeth are strongly developed for so small a shell. *S. capense*, Krauss, is thinner and has a more feeble dentition.

XLIII.—*New and obscure British Spiders.*

By the Rev. FREDERICK O. PICKARD-CAMBRIDGE.

[Plates XX. & XXI.]

SINCE my last contribution to the Ann. & Mag. Nat. Hist. in January 1891 few opportunities have offered themselves for working the likely places in the Lake Districts. A fortnight in the heart of the "Lakes" at Elterwater in July of last year, however, enabled me to do a little among the spiders, with the result that several rare and local species came to hand, while one addition was made to the British list—*Lophocarenum Mengei*, Sim.

A few days at Cannock, Staffordshire, in May of last year enabled me to add a fine species to science, *Tmeticus simplex*, F. Cb., while another very small spider, which I believe to be hitherto undescribed, turned up amongst some captures made in Dorset in 1888. This I have called *Leptyphantus plumiger*, though its exact generic position is somewhat doubtful.

To these new forms *Tmeticus Warburtonii*, Cb., perhaps ranks next in value; it occurred in some abundance along with its congener, *Tm. scopiger*, Grube, in Newton Moss, Penrith.

Other employments will not at present admit of my giving figures and descriptions of several other forms which are certainly new to science. Many of these are of the female sex; and though it is better to secure the males first, yet perhaps the simplest plan will be to describe and figure these as briefly and accurately as possible, trusting that time and an increased number of workers will contribute greatly towards finding partners for them.

I have taken this opportunity of publishing a few notes and figures of the differential characters of several obscure and closely-allied species—*Zilla atrica* and *Z. v-notata*, *Amaurobius similis* and *A. fenestralis*, &c.

New Species added to the British List, and two new to Science.

Fam. Therididæ.

Group L I N Y P H I N I.

Tmeticus simplex, sp. n.

(Pl. XX. fig. 5, A, B, C, D, E, F, G.)

Length of male $1\frac{1}{2}$ line; female slightly larger.

Both sexes.—*Cephalothorax* red-brown or pale yellow, elongate-oval, slightly narrowed and bluffly rounded in front. Caput slightly depressed in front; dorsal profile horizontal, slightly concave in middle, gradually inclined towards the base; median line set with six or eight isolated curved hairs.

Eyes large and closely grouped; posterior row straight, eyes equal, equidistant, one diameter apart; anterior row slightly curved, convexity forwards, centials smaller, half a diameter apart, one diameter from laterals.

Clypeus as high as ocular area, vertical.

Maxilla with several setigerous granulations.

Sternum as broad as long, light brown, set with short isolated black hairs, terminating behind between posterior coxæ in a conical point.

Legs dull yellow-brown, clothed with short hairs; femora without spines, exhibiting a double row of long fine hairs beneath; genua with one spine at apex; tibiæ i., ii., iii. with two spines on upperside, tibiæ iv.* with one spine only, situated towards the base. Tarsal claws 3; superiors slender, pectinate, inferior with one tooth.

Abdomen dull white-brown pinkish or darker olive-green, mottled with pale dull white spots, often exhibiting (female sex chiefly) a posterior, central, dorsal series of slender \wedge -shaped bars; ventral surface margined on either side with a pale line.

Male.—*Falces* four times the length of the clypeus; basal joint very stout, convex on upper side, striate on outer side, exhibiting on the outer side in front rather towards the apex some fine setigerous granules; attenuated and divergent towards apex, bearing between the inner angle and the apex a long, stout, slightly curving, bluntly pointed tooth, directed outwards and forwards, its apex set with a single fine hair; upper margin of fang-groove furnished with five small teeth (Pl. XX. fig. 5, B).

Palpus short; cubital joint one half longer than broad, bearing at apex a single curving spine. Radial joint twice as long as broad, clothed with short hairs, its outer, upper, anterior angle produced into a short, sharp, up-curving spur (Pl. XX. fig. 5, E (a)).

Digital joint very small, one half only longer than radial joint, prominent at base on outer side, clothed with hairs, its apex exhibiting four or five bristles. Palpal organs simple,

* Tibiæ i., iv., &c. signifies the tibial joints of the first pair or fourth pair of legs, as the case may be. Thus also femora i., ii., &c.

exhibiting at their base, rather beneath the radial joint, a short, curved, dark spur (the homologue of the falciform process) (Pl. XX. fig. 5, F (b)); bearing at their apex a spiraliform membrane supported on a fine black spiral spine (Pl. XX. fig. 5, F (c)).

Female.—*Falces* convex at base in front, vertical, scarcely attenuate or divergent at apex; upper margin of fang-groove bearing five sharp teeth, lower margin with three small granulations.

Palpus spinose, without terminal tarsal claw (Pl. XX. fig. 5, A).

Epigyne not much developed externally, presenting more or less conspicuously a pair of spermathecae (Pl. XX. fig. 5, C) and two pairs of dark, sinuous, tubular ducts.

This very distinct little spider is closely allied to Tin. denticchelis, Sim., and Tin. longisetosus, Em., but evidently quite different from either.

Sixty to eighty specimens were taken by myself upon the damp walls of a brewery cellar at Cannock, Staffordshire, in May 1891. The females constructed a small, round, flattened, pure white egg-cocoon in proximity with the delicate silken sheet forming the snare.

Cannock, Staffordshire.

Leptyphantes plumiger, sp. n. (Pl. XX. fig. 2.)

Male $\frac{2}{3}$ line.

Cephalothorax dull yellow-brown, horizontal above, abruptly depressed behind.

Eyes of posterior row large, situated in a straight line; centrals scarcely one diameter apart, half a diameter from the laterals. Anterior row straight; centrals much smaller, almost in contact, one quarter a diameter from the laterals.

Clypeus scarcely as high as the ocular area.

Falces short, stout, straight; upper margin of fang-groove furnished with two very small teeth.

Legs short, rather stout, clothed with fine hairs. Femora without spines; with a fringe of longer hairs beneath. Genual joints with a short fine spine at apex. Tibiæ with two fine erect spines, scarcely longer than the diameter of the joint. Metatarsi i. and ii. with one fine spine on the upperside near the base.

Abdomen dull sooty brown.

Palpi and palpal organs, *vide* Pl. XX. fig. 2.

This very small and obscure spider belongs to that little

group which seems to lie somewhere between *Leptyphantos*, *Bathlyphantes*, and *Porhomma*.

Two specimens were found amongst other species collected in Dorset in 1888. It is most probable that these were taken in Hyde Bog, near Wareham, in May or June.

Group LOPHOCARENINI.

Lophocarenum Mengei, Sim.

(Pl. XX. fig. 1, *a*, *b*, *c*, *d*.)

Length of male $\frac{3}{4}$ line.

Both sexes.—*Cephalothorax* oval, narrowed in front, dark red-brown or black, margins slightly impunctate, striae distinct.

Posterior row of eyes curved, convexity backwards. Eyes equal. Anterior row curved, convexity backwards; centrals much smaller.

Clypeus slightly inclined, as high as the ocular area.

Falces as long as the clypeus, convex at base, vertical; upper margin of fang-groove bearing three sharp teeth, two long, one short.

Sternum slightly longer than broad, dark black-brown, slightly impunctate, terminating behind between the posterior coxae in a broad square truncate piece.

Legs short, yellow-brown, clothed with fine hairs. *Tibiae* alone exhibiting a spine on upperside, these very small, barely visible. Tarsal claws three, superiors toothed. Tarsi iii. and iv. clothed beneath with numerous barbed hairs.

Abdomen dull olive-brown or black, glabrous, strongly and closely impunctate in both sexes.

Male with thick coriaceous covering or scutum over the whole dorsal area.

Female without scutum; anterior dorsal area exhibiting four small dull red rounded pits. Ventral surface paler, smooth, set with short hairs; pygidium exhibiting transverse wrinkles.

Male sex.—*Cephalothorax* exhibiting a high, vertical, globular, cephalic lobe (not always equally developed in every specimen), bearing on its anterior apex the posterior central pair of eyes; set with short erect pale hairs; exhibiting at its base on either side, immediately behind the lateral pair of eyes, a large, deep, oval excavation. Central region convex, dropping abruptly to the pedicle (Pl. XX. fig. 1, *a*).

Posterior row of eyes curved; centrals four diameters apart, placed on anterior apex of lobe (Pl. XX. fig. 1, b).

Anterior row curved; centrals much smaller, one diameter apart, two and a half diameters from laterals.

Palpus.—Cubital joint three times as long as its widest diameter. Radial joint two thirds the length of cubital, produced in front over base of digital joint into a long, tapering, straight spur, its apex slightly and abruptly hooked; its outer side set with a fringe of curving hairs. Palpal organs exhibiting at base on outer side beneath, a small hooked process, and at their apex a straight sharp spur, and adjacent to this a stout, spiraliform, curving, dark black spine. Digital joint slightly prominent on upperside at base (Pl. XX. fig. 1, c, 1, 2, 3).

Female sex.—*Caput* convex, thoracic dorsal outline concave in central region, convex behind, dropping abruptly towards the pedicle.

Posterior row of eyes curved, anterior margin of centrals in a line with posterior margin of laterals. Eyes equal; centrals one and a quarter diameter apart, one and a half diameter from laterals.

Anterior row curved; anterior margin of centrals in a line with the centre of laterals; centrals much smaller, half a diameter apart, one diameter from laterals.

Epigyne simple, presenting a transverse tongue-like central process, broader than long, bearing anteriorly on either side a small, circular, dark concavity; its posterior margin very slightly sinuous (Pl. XX. fig. 1, d).

Palpus bearing some stout spines; without terminal tarsal claw.

This very small but interesting species has been met with by M. Simon on the continent, but has never before been taken in the British Islands.

The male will be at once recognized by the large, globular, cephalic lobe and the radial joint of the palpus, and will not be mistaken for nemoralis, Bl., Blackwallii, Cl., belonging to the same genus.

It might be confounded with Peponocranium (Walekenaëra) ludicrum, Bl. But if it be noted that this latter species has long spines on the legs, that its integuments are not impunctate, and that the male has no abdominal dorsal scutum, there will be no confusion of the two spiders in either sex.

A dozen specimens were taken by myself in July 1891 on a swampy island in the middle of the Elterwater, near Ambleside, in the English Lake districts.

It forms another most interesting addition to the British arachnological fauna.

Notes on rare British Spiders, with Characters of some obscure and closely-allied Species.

Dictynidæ.

Amaurobius fenestralis, Stroem.

similis, Blk.

(Pl. XXI. figs. 10, 11, *a*, *b*, *c*.)

These two species occur in abundance in Cumberland and throughout the Lake districts. *A. fenestralis* is very common under stones and in the stone walls all over the fells near Carlisle, and may be always recognized by its smaller size.

The male may further be distinguished from *similis* by the straightness of the spur on the inner anterior angle of the radial joint.

The dark blotch on the anterior part of the abdomen is seldom or never divided as it is most frequently in *similis* (Pl. XXI. figs. 10, 11, *a*).

The females are not so easy to distinguish; but an examination of the epigyne will form a good, though I can scarcely affirm a certain, clue. There appears to be a want of stability in this portion of the female structure (Pl. XXI. figs. 10, 11, *b*). Pl. XXI. fig. 11, *c*, exhibits the nest of *A. fenestralis*, formed, between two stones, of bits of dry moss, insect debris, wings, legs, &c., while the female may be observed crouching beside her egg-sac in the centre.

This little species is never, so far as I am aware, found in outhouses or other buildings, nor have I ever taken it in very close proximity to buildings, though doubtless it will occur in the walls around farm buildings on the fells, where every wall contains numbers of specimens.

A. similis, on the other hand, is found abundantly, though not exclusively, in outhouses, stables, &c. There is scarcely a crevice in any garden-wall, paling, pallisade, which may not be tenanted by this ubiquitous spider. They are, however, also abundant in the fissures of the Red-Sandstone cliffs overhanging the streams, and in the quarries around Carlisle.

The males of this species may be recognized by the fact that the spur at the inner anterior angle of the radial joint is abruptly narrowed, its apex aculeate and much curved inwards and upwards towards the palpal organs.

For figures of the epigyne see Pl. XXI. figs. 10, 11, *b*, *c*.

Therididæ.

Section THERIDIONINI.

Phyllonethis lepidum, Wlk.

This interesting little species occurred in some abundance under stones in a marshy spot on the fells near the Tilberthwaite waterfalls in the neighbourhood of Coniston Water in July 1891.

It has hitherto only been taken in Dorset, so far as I am aware.

Section ERIGONINI.

Group LINIPHINI.

Genus LEPTYPHANTES.

Leptyphantes pinicola, Sim.

This little spider, added to the British list in Sept. 1890, was in evidence in an immature state upon Helvellyn in July 1891.

Leptyphantes ericæus, Blk. (Pl. XX. fig. 4, *a*, *b*, *c*.)

Length of male $\frac{7}{8}$ line.

Both sexes.—*Cephalothorax* almost as broad as long, narrowed in front; very pale dull yellow, with dusky marginal line. Ocular area prominent; eyes conspicuous, encircled with black. Dorsal profile-outline concave in centre, very convex behind, and abruptly sinking towards the base.

Clypeus scarcely as high as the ocular area, projecting a little forwards.

Falces two and a half times the height of the clypeus, long, vertical, straight, not attenuate or divergent towards apex; bearing three stiff hairs on inner side in front; outer side striate.

Sternum broader than long; brown, shining, convex, set with a few isolated black hairs; terminating between the posterior coxæ in a very broad squarely truncate piece.

Legs pale yellow, clothed with short hairs. Femora exhibiting beneath a double series of long fine hairs, the pair nearest the apex much longer; femora i. with a fine spine situated on the inner side a little towards the apex; femora ii., iii., iv. without spines.

Genua of all four pairs with a very long (three times the diameter) obliquely erect spine at apex. Tibiæ i. with two dorsal and two lateral spines on either side towards apex. Tibiæ ii. with two dorsal and one lateral spine towards apex. Tibiæ iii. and iv. with two dorsal spines only. Metatarsi of all four pairs with a single fine long (twice the diameter of the joint) spine towards the base.

Eyes large, closely grouped, seated on dark black spots. Posterior row straight, eyes equal, centrals scarcely half a diameter apart, a quarter of a diameter from the laterals. Anterior row straight, centrals a little smaller, almost in contact, scarcely one quarter a diameter from the laterals. The four central eyes form a quadrangle much narrower in front and longer than broad.

Abdomen oval, rather convex above, a little pointed towards the spinners; dorsal area pale dull yellow, sides and ventral surface dusky black.

Male.—*Palpus*. Humeral joint a little enlarged towards apex. Cubital joint very small, as broad as long, rounded. Radial joint narrow at base, enlarged in front and rounded; as broad as long. Both joints clothed with fine hairs; the radial joint exhibiting a single fine curving spine directed forwards.

Digital joint small, clothed with hairs. Palpal organs exhibiting on the outer side at the base a concave chitinous piece (falciform process), its outer margin bearing a short black spur directed inwards. At the apex close to the end of the chitinous sheath are two dark black spurs. The lateral stylum is developed into a pair of elongate lobes, not very distinct (Pl. XX. fig. 4, a, 1, 2, 3).

Female.—Rather larger than male, but similar in other respects.

Epigyne conspicuous, consisting of a short ovipositor-like prominence (Pl. XX. fig. 4, c), its apex exhibiting a transverse opening; from above presenting a semicircular form (Pl. XX. fig. 4, b).

This very small species is abundant amongst grass in the summer months. It will not be found very difficult to identify (though resembling Bathyphantes circumspecta) if it be first recognized as belonging to the genus Leptyphantes by the spine on the metatarsi.

The palpal organs of the male will furnish sure characters for its recognition; while the dusky abdomen, with its pale dorsal area, of the female, and the form of the epigyne will suffice for the identification of this sex.

Apparently generally distributed throughout the country.

Dorset ; Hertfordshire ; Epping Forest ; Cumberland ; and Scotland.

Leptyphantes alacris, Blk.

Males and females of this fine and rare spider were taken in some abundance amongst dead leaves in the woods at Wreay, near Carlisle, in April 1891.

Leptyphantes nebulosus, Sud.

Males and females of this somewhat local spider were taken at Cannock, Staffordshire, in May 1891, and also in Carlisle, Oct. 1892.

Genus BATHYPHANTES.

Bathypantes parvulus, Westr. (Pl. XXI. figs. 7, *a*, *b*.)

Length of male $1\frac{1}{2}$ line.

Cephalothorax dull yellow-brown, striæ and margins tinged with sooty brown.

Abdomen dull black, unicolorous.

Legs pale orange-yellow. Femora i. with two spines, one above the other in front of the joint about the middle. Femora ii. and iii. with a single spine above, about the middle; iv. without any spine. Tibiæ i. with a dorsal and a lateral spine upon either side of the joint towards the apex; ii. with a dorsal and one on the posterior side towards the apex; iii. and iv. with one spine towards the base, another towards the apex on the upperside.

Genual joints with a single spine at the apex. Metatarsi without any spines.

The *palpi* of the male are very similar to those of *circumspecta*, but the falciform process (or hook) is more densely clothed with a fringe of hairs on the inner side (Pl. XXI. fig. 7, *a* (*a*)). The spiral spine at the apex scarcely takes so wide a sweep, but is otherwise very similar to that of the above-named species (Pl. XXI. fig. 7, *a* (*b*)).

This species may perhaps be most readily distinguished by the fact that the abdomen exhibits none of the transverse bars so noticeable in *circumspecta*, being in fact unicolorous.

Having no females by me I am unable to give a figure of the epigyne. Both *parvulus* and *circumspecta* may be distinguished from *ericæa*, *tenebricola*, *zebrinus*, &c. by the presence in these species of a spine on the metatarsi.

Not nearly so common a species as the next ; but found

occasionally during the summer months in various parts of England.

Bathyphantes gracilis, Blk. (Pl. XXI. figs. 6, a, b, c, d.)

Syn. *Bathyphantes circumspecta*, Blk.

Length of male rather less than 1 line.

Cephalothorax dull yellow-brown.

Sternum dark brown.

Abdomen with distinct pattern. Dorsal area dull white or yellowish, bearing a series of dark, somewhat curved, transverse bars.

Legs pale yellow straw-colour, often suffused with brown, very long and slender. Femora i. with a spine above and another in front about the middle of the joint; ii. with a single spine above about the middle; iii. and iv. without spines.

Genua of all four pairs with a single spine at apex. Tibiæ i. with three spines at the apex, one dorsal and two lateral, and a single dorsal spine towards base. Tibia ii. with two spines at the apex, dorsal and posterior lateral, and a single one towards base. Tibiæ iii. and iv. with a single dorsal spine towards apex and another towards the base of the joint. Metatarsi without any spines.

The *palpi* of the male are very similar to those of *parvulus*, but the fringe of hairs on the inner margin of the falciform process of the palpal organs (Pl. XXI. fig. 6, a) is not so regularly distributed as in that species. The spiral spine at the apex takes a wide sweep, the central black spur lying within its circumference (Pl. XXI. fig. 6, b) is more distinct, while the lobe supporting this spine is more globular than in *parvulus*.

The pattern on the abdomen will, however, render its identification in both sexes comparatively easy; though in some specimens the abdomen is of a uniform dull yellow or brown, with scarcely a trace of the transverse bars.

For the epigyne see Pl. XXI fig. 6, c.

This is a very abundant spider amongst grass in the summer months, and will not be confounded with other small spiders belonging to the genus Leptyphantes (ericæa, tenebricola, zebrinus, &c.) if it be noticed that the metatarsi bear no spine above towards the base.

Genus TMETICUS.

Tmeticus scopiger, Grube.

„ *Wurburtonii*, Cambr.

I had the good fortune to meet with abundance of these
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two fine species in August last amongst the long grass in Newton Moss, near Penrith.

The latter has hitherto only been taken near Southport, Lancashire, by Mr. C. Warburton. Both species were adult at the same time, though *scopiger* had the advantage by about a week.

Though there has never been any real doubt as to the validity of *Warburtonii* as a species distinct from *scopiger*, yet it is satisfactory to be able to examine specimens taken side by side in the adult state and in considerable numbers. As far as my observations have extended, there are none of the perplexing intermediate forms between the two species; but in every example I have obtained the distinguishing characters have maintained the same distinctness of definition.

Tmeticus rufus, Wid.

Abundance of females and several males, both adult, occurred amongst dry leaves in the woods at Armathwaite, near Carlisle, in April 1891.

I have also since taken this fine species amongst dead leaves in the woods near Cannock Chase, June 1891.

Tmeticus silvaticus, Blk.

Females of this rare species were taken by myself on Beacon Hill, near Penrith, in the spring of 1891.

Genus PORHOMMA.

Porhomma adipatum, L. K.

The female of this rare spider was taken by myself near Penrith in April 1891; but so far I have not been able to meet with any specimens of the male sex, though both sexes have been taken in the Cheviot Hills.

Porhomma montigena, Sim.

This spider, described in my last contribution to Ann. & Mag. Nat. Hist. as new (under the name *Tmeticus niger*), would appear to be identical with M. Simon's *P. montigena*, which he states to be an inhabitant of alpine regions.

It was not adult when I visited the summit of Helvellyn in June 1891 and 1892, but I found it plentiful in an immature state.

Genus DECYMBIUM.

Decymbium tibiale, Blk.

Two adult males and a female of this very distinct species were taken by myself amongst dead leaves in the woods at Wreay, near Carlisle, in April 1891.

They are very similar to *D. (Veriense) nigrum*, Blk., but the stout, gouty, tibiae of the first two pair of legs render them easy to recognize in the male sex.

Genus TROXOCHRUS.

Troxochrus cirriformis, Cb.

An adult male of this apparently very distinct little species occurred near Carlisle in 1890.

M. Simon considers it to be merely a variety of *T. scabriculus*, Cb.; but unless an examination of a much larger number seems to give evidence of a gradation of the distinguishing characters, one would be inclined to consider it as a distinct species.

Genus AREONCUS.

Areoncus vaporariorum, Cb.

A single immature male, which I feel pretty confident belongs to this species, was taken by myself in a cellar at Cannock, Staffordshire, in June 1891.

Epeiridæ.

Zilla x-notata, Clerck. (Pl. XXI. figs. 8, *a*, *b*.)

Zilla atrica, C. K. (Pl. XX. fig. 3; Pl. XXI. fig. 9, *a*.)

The very common *x-notata* can be very easily distinguished from "*atrica*" (which is scarcely less common) in the male sex by the comparative shortness of the palpi (*vide* Pl. XXI. figs. 8, 9, *a*). The distinctions by which in the female sex these two species may be recognized are less easily observable.

In the first species the epigynal area appears as a narrow, transverse, black plate; while under a higher power it resolves itself into the form shown on Pl. XXI. fig. 8, *b*.

The same portion of structure in "*atrica*" exhibits under a low power a similar appearance, but at its apex can easily be observed a cordiform dull white prominence (Pl. XXI. fig. 3).

These two characters—the one characteristic of the males, the other of the females of these two otherwise closely allied species—will be found quite sufficient for distinguishing them; but there are other characters, drawn from the colouring of the abdomen, which will help very greatly in determining their identity, though not so reliable as the above.

The shoulders of the abdomen are in "*x-notata*" sooty black and the whole abdomen is of a sooty or silvery grey colour; while in "*atrica*" the shoulders are rusty red-brown and the abdomen is of a delicate yellow, suffused at the sides with bright orange-red.

The clear yellow V-shaped space on the sternum is usually in "*atrica*" broader than in "*x-notata*;" but further comparison of a vast number of specimens has shown me that this character again, though a good one, is by no means reliable.

It may be regarded as a general rule that "*Z x-notata*" constructs its web on stone bridges, in the angles of walls, windows, greenhouses, old buildings, &c., while "*atrica*" is seldom found far away from foliage of some sort.

But I have lately taken "*x-notata*" plentifully side by side on a holly-hedge with "*atrica*," and I have taken "*atrica*" on railings, bridges, and, singularly enough, on the "Roman wall," far away from trees of any sort.

Both these species are very abundant in and about Carlisle, and, indeed, throughout the country; but since no figures of the distinguishing characters of the females have yet been published by our English authorities, I have ventured to give them on Plate XX. fig. 3 and Plate XXI. fig. 8, b.

List of Species noted and described.

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|--|---|
| <i>Amaurobius similis</i> , Blackw., p. 380. | <i>Tmetiscus scopiger</i> , Grube, p. 393. |
| — <i>fenestralis</i> , Stroem, p. 389. | — <i>Warburtonii</i> , Cambr., p. 393. |
| <i>Phyllonethis lepidum</i> , Wlk., p. 390. | — <i>simplex</i> , F. Cb., p. 384. |
| <i>Leptyphantus pinicola</i> , Sim., p. 390. | — <i>rufus</i> , Wid., p. 394. |
| — <i>nebulosus</i> , Snd., p. 392. | — <i>silvaticus</i> , Blk., p. 394. |
| — <i>ericæus</i> , Blk., p. 390. | <i>Porhomma adipatum</i> , L. K., p. 394. |
| — <i>plumiger</i> , F. Cb., p. 386. | — <i>montigena</i> , Sim., p. 394. |
| — <i>alacris</i> , Blk., p. 392. | <i>Decymbium tibiale</i> , Blk., p. 395. |
| <i>Lophocarenum Mengei</i> , Sim., p. 387. | <i>Trochocrus cirrifrons</i> , Cambr., p. 395. |
| <i>Bathypantes parvulus</i> , Westr., p. 392. | <i>Areoneus vaporariorum</i> , Cambr., p. 395. |
| — <i>gracilis</i> , Blk., p. 393. | <i>Zilla x-notata</i> , Clerck, p. 395. |
| | — <i>atrica</i> , C. K., p. 395. |

EXPLANATION OF THE PLATES.

PLATE XX.

- Fig. 1. Lophocarenum Mengei*, Sim.
 a. Profile of male.
 b. Cephalic eminence from above.
 c. Left palpus of male.
 d. Epigyne of female.
- Fig. 2. Leptyphantes plumiger*, F. Cb. Palpus of male.
 a. Falciform process.
 b. Lower branch of lateral stylus, enlarged.
 c. Upper branch of ditto, enlarged.
- Fig. 3. Zilla atrica*. Epigyne of female from above.
- Fig. 4. Leptyphantes ericæus*, Blk.
 a. Left palpus of male: (1) falciform process; (2) lateral stylus; (3) apical spines.
 b. Epigyne of female from above.
 c. Lateral view of ditto.
- Fig. 5. Tmeticus simplex*, F. Cb.
 A. Profile of female, highly magnified.
 B. Caput and falces of male from in front.
 C. Left falx of female.
 D. Epigyne of female.
 E. Palpus of male from above: (a) outer spur of radial joint.
 F. Palpus from outer side: (a) spur of radial joint; (b) falciform process of palpal organs, very small in this species; (c) spirali-form membrane.
 G. Left palpus from above.

PLATE XXI.

- Fig. 6. Bathyphantes gracilis*, Blk.
 a. Left palpus of male from the outside: (1) falciform process; (2) spiral spine; (3) lateral coil.
 b. Ditto, exhibiting apex of palpal organs: (1) spiral spine; (2) termination of lateral coil.
 c. Epigyne of female.
 d. Lateral view.
- Fig. 7. Bathyphantes parvulus*, Wstr.
 a. Left palpus of male from the outside: (a) falciform process; (b) spiral spine.
 b. Epigyne of female from above.
- Fig. 8. Zilla x-notata*, Clerck.
 a. Right palpus of male.
 b. Epigyne of female from above.
- Fig. 9. Zilla atrica*, C. K.
 a. Left palpus of male.
- Fig. 10. Amaurobius similis*, Blk.
 a. Female; legs and palpi truncated.
 b. Epigynal area from above.
 c. Epigynal area—taken from a less mature specimen.
- Fig. 11. Amaurobius fenestralis*, Stroem.
 a. Female; legs and palpi truncated.
 b. Epigynal area from above.
 c. Female and cocoon within silken nest constructed beneath a stone.

[The above figures are all more or less highly enlarged.]

XLIV.—*Description of a new Moth of the Genus Anaphe from Madagascar, with a Note on the Natural Position of the Genus.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE following new species, together with its long fusiform social cocoon (not unlike that of *Hypsoides bipars*), was obtained by the Rev. J. Wills in the forest of East Imerina:—

Anaphe aurea, sp. n.

Wings above uniform pale silky golden buff, the males with the basal half of the costal margin slenderly edged with black; below, the borders of the wings are more ochraceous than above. Body above testaceous, with the head and collar more or less deeply orange; antennæ and eyes black: body below deep ochreous, the inferior edge of the palpi, a few hairs at the front of the pectus, and the tarsi of all the legs black; the tibiae of the anterior and middle pair black, fringed with ochreous, those of the posterior pair blackish at their distal extremity; anal tuft of female silvery above, otherwise coffee-brown.

Expanse of wings, ♂ 51, ♀ 62 millim.

Forest of East Imerina, Madagascar.

Four males and two females were sent with the cocoon.

The position of the genera *Anaphe* and *Hypsoides* has long been debated by Lepidopterists. Thus Walker (Lep. Het. iv. p. 856) described *Anaphe* as a genus of the family Liparidæ, whilst Herrich-Schäffer in the same year referred it to the Notodontidæ under the generic name *Arctiomorpha*; whereas Dr. Boisduval (Voy. de Delegorgue, 1847) seems to have imagined that it was an Arctiid. In his article on *Anaphe* (Trans. Linn. Soc. 1885) Lord Walsingham speaks of some of its characteristics as shared by *Cnethocampa*, and M. Mabille, speaking of his genus *Cænostegia* (a synonym of *Hypsoides*), says that it belongs to a special division of *Bombyx* approaching nearly to the European *Cnethocampa* (Bull. Soc. Ent. France, 1890 (published 1891), p. cxlvi).

Mr. G. F. Hampson, who has recently made a careful study of the families of the Lepidoptera, has pointed out to me that under the so-called Lasiocampidæ of authors two very distinct families are confounded, one of which (the true Lasiocampidæ) has the lower radial vein of the anterior wings emitted from the posterior angle of the cell; the other (Eupterotidæ, Hampson) emits this vein from the centre of

the discocellular veinlet. The Eupterotidæ moreover can at once be distinguished from the Lasiocampidæ by the important character of their well-developed frenulum, this being entirely absent in the Lasiocampidæ. The larvæ of the Lasiocampidæ are densely hairy, often with long thick tufts directed forwards on either side of the head, or backwards from the anal segment, as in the Liparidæ (to which Mr. Hampson considers them allied); whereas the larvæ of the Eupterotidæ are more Arctiid in character, such hairs as there are, whether few or many, being chiefly emitted in tufts from wart-like excrescences.

There can be no doubt whatever, from the entire structure of the moths and the character of their larvæ, that *Anaphe* and *Hypsoides* must be placed in the family Eupterotidæ of Hampson.

XLV.—*The Interpretation of the Sponge Organism, and some Recent Works on Sponges.* By Dr. OTTO MAAS*.

SINCE the investigations of F. E. Schulze on the structure and development of sponges paved the way, probably all zoologists have looked upon these animals as *three-layered*, consisting of an outer and an inner layer of epithelium, and enclosed by these a connective-tissue mass with cells and deposits of various kinds. This method of interpretation does not take into consideration the question whether the three layers correspond to the layers which arise from ectoderm, endoderm, and mesoderm in higher animals, and also does not necessitate our holding any particular view regarding the systematic position of sponges. As a matter of fact the adherents of the most divergent theories on this point—both those who derive sponges from a special class of Protozoa separated from other Metazoa, and those who consider them as true Metazoa, but as a special phylum, as well as, finally, those by whom sponges are regarded only as a degenerate branch of the Coelenterate stem—have all recognized the three-layered structure of sponges in their speculations.

Another question specially referring to the group of sponges would be whether the three layers of the *adult* arise in the development of the individual sponge from three separate

* Translated from a separate impression, communicated by the Author, from the 'Biologisches Centralblatt,' Bd. xii. nos. 18-19, pp. 560-572 (Oct. 1892).

germinal layers or from two only. F. E. Schulze has frequently given prominence to this distinction between the layers of the adult and of the embryo, and has said that sponges can only be regarded as triploblastic animals if, in the undifferentiated embryo and before histological separation, three cell-layers, distinct from one another but undifferentiated in themselves, could be distinguished—a state of things which, to my knowledge, has not yet been demonstrated with certainty in any sponge. However that may be, in the *adult* sponge at all events, since the lead given by Schulze, the covering layers of epithelium have to be sharply distinguished from the third layer, the enclosed connective-tissue substance with its various contained elements.

In this triple division, which is founded on the relative position of the layers and is supported by histological discoveries, a correction has recently been made by Topsent*, which at first sight appears not unimportant, but which, it seems to me, makes little fundamental alteration. This author distinguishes, to begin by summarizing his chief results in this respect, four kinds of cells—referring first to the boring sponges and then to the *Halichondriæ*—namely (1) *cellules contractiles*, (2) *vibratiles*, (3) *conjunctives*, and (4) *digestives pigmentées*. The first and second constitute, according to him, the ectoderm and endoderm, the others the mesoderm. By contractile cells he understands those which, as he points out, from their position and appearance have hitherto been regarded as ectoderm and endoderm or as “fibres,” the contractile fibre-cells of the mesoderm. When he further says that the latter are the only elements which have been made answerable for the contractility, he does not at the same time take into consideration the fact that contractility and mutability of form have also been usually accorded to the epithelial ectoderm cells. For how can authors otherwise have formed a conception of the opening and closing of pores? Moreover there is to be found in the literature a whole series of special examples, in which reference is made to alterations in the form of the ectoderm cells—by Lieberkühn in *Spongilla*, by F. E. Schulze in *Sycandra*, by myself in the young and by Weltner in the adult *Spongilla*, by Vosmaer in *Myxilla*, and so on. Further, it is not justifiable to comprise offhand in one group the cells of the external skin and the contractile elements in the interior, however similar the two kinds of cells may appear

* Topsent, E., “Contribution à l’Étude des Clionides,” Arch. Zool. expér. v. *bis* Suppl.

histologically. The former constitute the covering in the region where the body of the sponge is bathed by the water, but the latter lie *inside* a connective tissue, and hence cannot be termed ectoderm, so far as regards the adult differentiated sponge.

It is somewhat different if we extend our investigation and raise the question whether in the course of the phyletic development of sponges the covering epithelium cells and the contractile elements were not one and the same, and whether we do not find even now a similar relation in primitive sponges, as E. A. Minchin has done *. He has described in the oscula of a calcareous sponge generally held to be of primitive and simple structure a sphincter which contracts these openings so readily that they have hitherto not been seen. This sphincter consists of two epithelial layers of flat, spindle-shaped, ectoderm cells; of mesodermal elements there are only wandering cells to be observed here and there; hence Minchin concludes with reason that here the very energetic contraction is only brought about by the ectoderm. Minchin yields indeed too much to Topsent when he subsequently expresses the opinion that all authors have called the muscle mesodermal; but he applies Topsent's and his own results in a more correct manner when he says "that in a highly specialized sponge muscular cells which originally formed a part of an epithelium became more specialized and sank into the mesoderm."

I find the most developed condition in this respect in the horny sponges, according to F. E. Schulze's well-known description. There "contractile fibre-cells," easily recognizable by their structure, lie in great quantities in the mesoderm, *i. e.* in the connective-tissue mass, often arranged in strands and sometimes forming complete concentric layers round the canals; on the other hand, the covering layer also has become further differentiated, the cells of the epidermis have secreted a fine cuticle, and as far as this extends their power of contraction must be at an end. Thus we have here the division of labour carried to its fullest extent.

On the contrary, we have before us, not only in the sphincter but in the whole structure of *Leucosolenia clathrus*, a more primitive condition, as Minchin's histological discoveries show †. The sponge itself has great power of contraction, and the different forms that have thus arisen were earlier regarded as varieties and then as stages of development. In

* E. A. Minchin, "Oscula and Anatomy of *Leucosolenia clathrus*," Quat. Journ. Mic. Sci. xxxiii. p. 4 (June 1892).

† E. A. Minchin, "Some Points in the Histology of *Leucosolenia clathrus*," Zool. Anzeiger, 1892, no. 391.

reality they are only phases of contraction, which pass somewhat quickly into one another; and if the ectoderm be investigated in different stages of contraction all gradations are found, from an ordinary flat cell (where the sponge is expanded) to completely mushroom-shaped cells, which show the chief mass of the cell-body displaced deeply inwards (where the contraction is very strong). The connective-tissue substance contains no elements for contraction; the wandering cells occurring in it are easily distinguished by their nucleus with nucleolus and their dissimilar contents from the contractile cells with uniformly granulated protoplasm and nucleus with a network. Since besides these there are only spicules with their cells and sexual products to be found in the middle intermediate cell-mass, and as, further, the above-mentioned ectoderm cells appear regularly in a form corresponding to the contraction for the time being, it may be rightly concluded that the seat of contractility in this simply built sponge is still specially in the outer epithelial layer. The simplicity of *Leucosolenia clathrus* is of course shown also in the fact that it does not yet possess any separate flagellated chambers, but that the whole internal cavity is evenly clothed with collar-cells. The latter necessarily take a passive share in the contraction, and then become compressed in transverse diameter, corresponding to the direction of contraction, and hence longer.

Through the discoveries of Minchin as well as of Topsent our attention is again drawn to the question referred to above, raised by F. E. Schulze, as to whether sponges which show three layers in the adult condition are not nevertheless merely diploblastic animals ("Metamorphose von *Sycandra raphanus*," Zeitschr. f. wiss. Zool. Band xxxi., 1878). The two recent authors seek to arrive at a conception of the intermediate layer by the histological method, since they look upon its elements as not equivalent in themselves, but as standing in closer or more distant relation to the primary layers. Topsent's merit appears to me to consist in that he recognizes the contractile cells of the intermediate mass as being much more similar to the covering-cells than are the cells of the intermediate mass among themselves; of the latter there still remain to him as specially mesodermal the *cellules conjonctives* (in which the skeletogenous cells must also be included) and the *digestives pigmentées*. Minchin also has attempted a similar solution of the intermediate layer into its heterogeneous

elements, and after separating out the contractile cells as of epithelial origin, he regards as "mesodermal organs" proper only the skeleton and the genital products. "Cellules digestives pigmentées" he does not mention among them; but these from their function—according to the one author they take up food-stuffs, according to the other they only transport them further from the digesting flagellated cells—must stand in closer relation to the covering of the surface and of the interior, or, rather, become set free directly from it.

However justifiable it may be to apply the histology, especially of a primitive sponge, to the interpretation of the middle layer, nevertheless we may expect still better explanation from the *developmental history*. In the development of *Sycandra* F. E. Schulze has incidentally shown that in this sponge there are present at first in any case only *two* germinal layers, which afterwards form the three layers of the adult, inasmuch as from the flagellated cells of the larva arises only the endodermal system, and all remaining elements spring from the larger non-flagellated cells of the embryo. With regard to this it may be pointed out that he (at that time surely not without intention) enumerates the differentiations of this layer in the same serial order in which, as it now appears, they were laid down both in the ontogeny and phylogeny. He says, for example, "Shall now this layer of tissue thus constituted, in which the skeletal parts arise, the genital cells are formed, and in places even contractile fibre-cells occur, be termed mesoderm, and its outer flat epithelial covering ectoderm, or not?" He arrives at a negative conclusion, because all these elements are differentiated out of *one* embryonic cell-layer. How this indubitable process is carried out in detail has still, as is well known, to be investigated.

In a larva, the structure and metamorphosis of which appear to permit a comparison with *Sycandra*, it was my good fortune to be able to follow * this differentiation somewhat more closely, and particularly to determine how the various elements of the middle layer become separate at different periods of the ontogeny. The larva of *Esperia* (as also a series of other Desmacidonidæ-larvæ investigated by me) consists, apart from complications of detail, in the main of *two* different layers—first of a layer of small and very slender flagellated cells, with minute nuclei, which lie more anteriorly and make up the greater part of the surface of the larva; and secondly of a much more bulky layer of much

* O. Maas, "Die Metamorphose von *Esperia Lorenzi*, nebst Beobachtungen an anderen Schwammlarven," Mitl. d. Zool. Station zu Neapel, x. Bd., 3 (1892).

larger cells, together with spicules, which forms the surface only at the hinder pole, and in addition makes up the interior of the larva. In fixation, which takes place with the anterior pole, the small flagellated cells come to lie in a reversed position in the interior, and the whole remaining mass grows round them. From the former arise the flagellated chambers and the efferent canals in part, while from the cells of the latter are formed all the remaining constituent parts of the sponge.

The separation of *some* of the elements has already been completed in the larva, so that two kinds of cells can be recognized in it and spicules are formed in quantities; but *other* elements first become differentiated after the metamorphosis. The two kinds of cells in the large-celled mass are, first, such cells as are provided with a nucleus and nucleolus and contain deposits of unequal size, and, secondly, cells the nucleus of which shows a network and which contain a uniform protoplasm. From the former arise the amoeboid wandering cells, which, as is known, give rise to the genital products; while the latter, with uniform protoplasm, have various destinations. After metamorphosis they for the first time separate into the cells of the outer covering and into the contractile elements, which come to lie in the parenchyma of the intermediate mass; they are thus identical with the "ectoderm," the "cellules contractiles" of Topsent. The separation takes place relatively late; even during the metamorphosis the "mesodermal" muscle-cells and the "ectodermal" covering-cells cannot be distinguished from one another, especially at the marginal parts; their separation first becomes distinct with the formation of the canal-system. In these siliceous sponges also the contractile elements often form whole tracts; the differentiation, however, never goes so far as in the horny sponges; the "ectoderm," *i. e.* covering-cells, never lose their contractility, and throughout life look histologically very similar to the corresponding elements in the intermediate mass.

On this account there is no ground for designating this covering and the contractile elements as ectoderm simply, as Topsent has done, even after I have shown their common derivation. The spicule-forming cells and the amoeboid wandering cells might just as well be termed ectoderm. It is true that they are separated in the embryos much earlier than the muscular elements, but this is a difference of degree and not of kind.

On the whole the circumstances are instructive under

which the various tissue-elements are gradually differentiated from the principal mass of the larva which remains after deducting the collar-cells. *First are separated the supporting skeletal substance and the cell material from which the genital products arise. At a later period the epithelial covering-layer and the contractile elements first become separated. Much later still the cells appear differentiated which glue the spicules together into bundles by secretion of spongin.* The ontogeny of *Esperia* furnishes a good indication as to how these must have developed in the course of ontogeny. Naturally displacements and abbreviations in point of time must not be left out of consideration; thus, for example, in the phylogenetic history of sponges the formation of spicules and fixation have universally and with reason been brought into connexion with one another; but a whole series of free-swimming sponge-larvæ show spicules already present. On the whole, however, the sequence of events among themselves and the nature and manner of differentiation may be taken as good guides to conclusions.

The development of *Esperia*, and indeed of *Sycandra* also, has a parallel in the phylogenetic stage represented by *Ascetta clathrus* in the sponge series. In this simple sponge we have, according to Minchin, little more than skeleton and genital products in the intermediate tissue; the seat of contractility lies still especially in the epithelial covering, just as must have been the case, according to the development of *Esperia* and *Sycandra*, in phylogeny, and in very primitive forms must still be.

From a series of cases in which the development of spongin is more accurately known to us we are well justified in speaking of a diploblastic embryo. We could distinguish in it, according to the cases before us, an ectomesoderm and an endoderm; but these names at once entail a comparison with the germinal layers of higher animals, and the preceding discoveries were intended to be kept within the limits of the group of sponges.

Berlin,
July 20, 1892.

XLVI.—Description of a new Species of the Homopterous Family Cicadidæ. By W. L. DISTANT.

Fam. Cicadidæ.

Subfam. *CICADINÆ*.*Cicada timorensis*, sp. n.

♂. Body above castaneous. Head with a central spot to front, the anterior angles of the vertex and a spot on base at inner margins of the eyes pale ochraceous; ocelli dark shining ochraceous; a small dark spot on the anterior angles of the vertex just above the insertion of the antennæ and a similar spot on the ochraceous area at the inner margins of the eyes; eyes olivaceous or castaneous. Pronotum with the anterior, lateral, and posterior margins ochraceous, its disk much varied with the same hue and with a pale central longitudinal fascia, widened posteriorly, where it contains two distinct castaneous spots; posterior margin inwardly castaneous. Mesonotum ochraceous, with five large castaneous spots, four obconical (of which the two central are smallest) starting from the anterior margin, the fifth basal and triangularly produced across disk. Metanotum and cruciform elevation ochraceous, the last with its anterior angles dark castaneous. Abdomen castaneous, the basal segmental margins pale tomentose. Head beneath, sternum, legs, rostrum, and opercula pale ochraceous; face with a triangular spot at base and a central fascia castaneous; abdomen with the posterior segmental margins and the anal appendage ochraceous.

Tegmina and wings pale hyaline, their extreme bases ochraceous, each with two small dark spots; the venation dark ochraceous or castaneous; tegmina with the costal membrane ochraceous.

The rostrum extends to the posterior coxæ; the opercula are about half the length of the abdomen, their inner margins straight and contiguous, their apices broadly convex, their outer margins moderately concavely sinuate.

The face is very strongly transversely striate.

Long., excl. tegm., ♂ 26 millim.; exp. tegm. 80 millim.

Hab. Malayan Archipelago; Timor.

This species is nearest allied to *C. coronata*, Dist., from which it differs by the different colour-markings, the opercula not overlapping at their inner margins, &c.

XLVII.—*Contributions to a Knowledge of the Entomology of the Transvaal.* By W. L. DISTANT.

SINCE I published the enumeration of the insects I collected when in the Transvaal some other collections have been received belonging to different orders. The novelties I propose to describe as I find opportunities to work out the collections.

COLEOPTERA.

LONGICORNIA.

Lamiidæ.

Mullonia granulata, sp. n.

Pale fuscous; elytra with two transverse, broken, inacular, creamy-white fasciæ not reaching the median suture, the first about central and consisting of three irregularly-shaped and fused spots on each elytron, beneath which are one or two dots of the same colour; the second macular fascia is near the apex and consists of two small sinuated and well separated spots on each elytron surrounded by a few dots of the same hue; the colour round these pale spots is irregularly darker and there are some slender dark discal streaks between the two fasciæ. The pronotum has two subobsolete greyish streaks on the basal half of each lateral margin.

The antennal tufts are well developed and dark fuscous in hue; the head has a distinct central longitudinal and very slender striation, on each side of which is a dark brown line; the pronotum is coarsely granulate, but less strongly on the anterior area, the granules being most numerous between the lateral spines; the elytra are very coarsely but somewhat sparsely punctate; the frontal portion of the head from the base of the antennæ is very coarsely punctate and the body beneath more sparingly so.

. Long. 21 millim.

Hab. Transvaal, Pretoria.

This species is allied to *M. albosignata*, from which it differs by the distinct granulation of the pronotum and the almost obsolete lateral greyish fasciæ to the same, the different size and pattern of the subapical macular fascia to the elytra, &c.

LEPIDOPTERA.

HETEROCERA.

Eupterotidæ.

Sangatissa pretoriæ, sp. n.

Head and thorax above pale ochraceous; the disk of the pronotum is rubbed in the specimen described, but there is evidence of a large black discal patch, which appears as a large hour-glass-shaped spot on bases of pronotum and abdomen; abdomen above ochraceous, with three longitudinal pale castaneous fasciæ; the segmental margins are very narrowly and obscurely dark fuscous; body beneath pale ochraceous; eyes and antennæ blackish.

Wings above pale ochraceous; anterior wings with a dark fuscous longitudinal fascia in cell; a central discal series of transverse fuscous fasciæ placed between the nervules, that below the lower median nervule very large and preceded by a basal spot; an outer discal transverse series of fuscous fasciate spots preceding a submarginal fuscous fascia and two fuscous spots at base beneath the submedian nervure. Posterior wings with a central transverse fuscous macular fascia, an outer discal series of subquadrate fuscous spots placed between the nervules, and a submarginal fuscous fascia. Fringe of both wings warm ochraceous. Wings beneath with all the fuscous markings much paler and subobsolete.

Exp. wings 108 millim.

Hab. Transvaal, Pretoria.

In this species the two upper median nervules are emitted somewhat close together at the apex of the cells of both wings, and I have to thank Mr. Hampson for his examination and decision of the true generic position of this fine moth. Mr. Butler also kindly showed me an unnamed specimen from Natal in the collection of the British Museum.

XLVIII.—*Description of a new Bat of the Genus Artibeus from Trinidad.* By OLDFIELD THOMAS.

In a small collection of bats recently presented to the Museum by Mr. J. H. Hart, the Superintendent of the Botanic Gardens, Trinidad, there is a single specimen of an *Artibeus* closely allied to *A. bilobatus*, Peters, but clearly representing a new species of this interesting genus. I propose to name it in honour of its discoverer, to whom the

Museum is indebted for many additions to its collection of Trinidad animals.

Artibeus Hartii, sp. n.

Size rather smaller than in *A. bilobatus*. Colour, so far as can be made out in a spirit-specimen, dull brownish grey, the bases of the hairs decidedly lighter than the tips; upper and under surfaces of apparently just the same shade; no white markings on face or back. Nose-leaf very short and broad, the breadth of the upright portion almost equal to its height; horizontal portion entirely bound down to and continuous with the muzzle in front, on the sides notched in the position of the extra lobes in *bilobatus*, but without the lobes themselves. Ear short, rounded, the notch behind the antitragus scarcely perceptible, but a marked emargination in the outer edge of the ear just above the tip of the tragus.

Skull, when viewed from the side, lower in the muzzle and more abruptly elevated above the orbits than in *A. bilobatus*.

Dental formula as in *A. planirostris* and *bilobatus*, i. e. $I. \frac{2}{2}, C. \frac{1}{1}, P. \frac{2}{2}, M. \frac{3}{3} \times 2 = 32$, this formula characterizing the subgenus *Uroderma* of Peters. Median upper incisors broad, pointed in the centre of their cutting-edge. Canines short and stout, their tips not projecting downwards beyond those of the posterior premolars. Shapes and proportions of molars very much as in *A. bilobatus*, except that the postero-internal angle of $\frac{m-1}{2}$ projects inwardly some way beyond the inner edge of $\frac{m-2}{2}$, while the two are about level in that species. Lower teeth also as in *A. bilobatus*, except that the posterior premolar is as short horizontally as the anterior, and is therefore decidedly shorter than $\frac{m-1}{2}$.

Dimensions of the type (a slightly immature* male in spirit):—

Head and body 52 millim.; nose-leaf, height of lancet 5.5, breadth of lancet 4.2, breadth of horseshoe 5.5; height of ear 12.5; forearm 38; third metacarpal 35; tibia 13.6; foot 9.5.

Skull: basal length 16.8; distance from front of canine to back of $\frac{m-2}{2}$ 7.0; breadth of palate outside $\frac{m-1}{2}$ 8.2; vertical length of upper canine 2.9.

This species is only the third known member† of the sub-

* The epiphyses of the limb-bones are not fully ossified, but the teeth are all up and in use.

† According to Dobson's Catalogue; but I strongly suspect that Peters's *A. concolor*, considered in that work as a mere variety of *A. planirostris*, ought properly to be reckoned as a distinct species, equally dis-

genus *Uroderma*, and may be readily distinguished from the other two, *A. planirostris* and *bilobatus*, by its nose-leaf being bound down to the muzzle in front as well as by the detailed differences in external structure and dentition above described.

XLIX.—*Note on Mexican Examples of Chilonycteris Davyi*, Gray. By OLDFIELD THOMAS.

WITH the specimens of *Geomys Bulleri* described in the August number of the 'Annals' (*suprà*, p. 196) Dr. A. C. Buller has sent to the Museum five specimens of a *Chilonycteris* apparently referable to the Trinidad and Brazilian *C. Davyi*, Gray, but distinguished at the same time by their brilliant fulvous-chestnut colour and by their slightly smaller size. The species was incidentally recorded from Mexico by Prof. Peters in his paper on the group*, but no Mexican, or even Central American, specimens have previously come to England. On direct comparison now with the type from Trinidad and with Dominican and Venezuelan specimens I have come to the conclusion that the Mexican ones ought to be subspecifically separated on the colour and size characters above mentioned, and would propose for them the name of *Ch. Davyi fulvus*, subsp. n. The brilliant fulvous colour is not unlike that of male specimens of *Natalus stramineus*, but does not seem to be, as in that animal, a sexual character, for Dominican examples of both sexes are of precisely the same greyish or brownish hue.

The forearm of the type measures 43 millim. in length, and in the four other specimens 42·5, 43·5, 44, and 45.

Dr. Buller obtained the specimens at Las Peñas, west coast of Jalisco, on the 20th November, 1891.

L.—*Two new Buprestidæ from Damma Island*.
By CHARLES O. WATERHOUSE.

AMONG the insects collected by Mr. J. J. Walker during the cruise of H.M.S. 'Penguin' is a small collection made at Damma Island, north-east of Timor. The species are mostly small, and will require much time to determine; but two fine

tinguishable with that animal, however, from *A. Hartii* by the characters of its nose-leaf. It is also somewhat larger, having, as Dr. Matschie, of the Berlin Museum, kindly informs me, the second skull-measurement above given 7·5 millim., and the third 9·9 or 10; its forearm measures 47 millim.

* MB. Ak. Berl. 1872, p. 361.

Buprestidæ are certainly new, and of these I subjoin descriptions. In order to make the position of one of these clear I must first make some remarks on the following genera :—

CHRYSOEDEMA, PSEUDOCHRYSOEDEMA, and PARACUPTA.

The species of *Chrysodema* have metallic tarsi and have in nearly all cases a smooth, slightly raised, median line to the thorax.

The species of *Paracupta* have yellow tarsi and an impressed median line to the thorax.

Pseudochrysodema, Saund. (Cist. Ent. i. p. 223), occupies an intermediate place between these, having yellow tarsi, but having a raised median line to the thorax; it has, moreover, a distinct projecting angle to the elytra just below the shoulder.

The interesting species which I describe below has yellow tarsi and a raised median line to the thorax, and has also a subhumeral angulation. In these respects it comes nearest to *Pseudochrysodema*; it has, however, quite a different appearance from the two described species, having evenly convex elytra, the thorax with scarcely any trace of lateral impression, but at the base of the thorax are two small, elongate, sharply cut foveæ, which are not present in *Pseudochrysodema* nor in any species of *Chrysodema* known to me. I think, nevertheless, that it would be premature to propose a new genus for the present species.

Pseudochrysodema (?) *Walkeri*, sp. n.

Aureo-viride, nitidum; thorace subtiliter punctulato, linea mediana vix elevata lævi, lateribus leviter impressis crebrius punctatis, basi utrinque fovea parva insculpta; elytris nigro-cyaneis, convexis, punctatis, haud costatis, ad apicem bene acuminatis acute serratis; tarsis flavis, unguibus seneis; antennis articulis 3^o–11^m nigris.

Long. 15 lin.

The thorax is gently convex, only slightly narrowed in front, finely and not very closely punctured on the disk, more closely and rather more strongly punctured at the sides, which are very lightly impressed at the middle; there is a smooth slightly raised median line, with the usual impressed punctured line on each side of it; the posterior angles are nearly right angles, and do not project laterally; on each side of the base, at a short distance from the posterior angles, there is a short, oblique, narrow, deeply impressed fovea. The elytra are convex, most so at a short distance from the base, with a

distinct projecting angle just below the shoulder, and with the margins at the apical portion strongly and acutely serrate, distinctly punctured, except near the suture at a short distance from the base, the usual costæ indicated by lines of punctures. The underside of the insect resembles that of *Chrysodema radianum*, but is more golden, and all the median area is more flattened; this is particularly noticeable at the inner part of the posterior coxæ, which forms a more distinct angle with the rest of the coxa. The tarsi are pale rusty yellow. The apical segment of the abdomen has a very small acute notch.

Cyphogastra abdominalis, sp. n.

Viridis, nitida: thoracis disco utrinque cyaneo suffuso; elytris sat fortiter punctatis, ad apicem lævioribus, fere nigris, ad latera postice aureo-viridi suffusis, margine ipso cupreo tincto; corpore subtus aureo-viridi, lateribus abdomineque læte cupreis, hoc vittis quatuor sordide albis ornato.

Long. 13-16 lin.

Very like *C. nigripennis*, Th., but rather broader and more strongly punctured, with the apex of the elytra formed as in *C. calepyga*, Th. The elytra nearly black, but have a distinct dark blue shade in some lights, the margins more or less green or golden green. The body beneath is green (with the usual yellow powder here and there), with the sides, and especially the abdomen, reddish coppery.

Two examples show a slight pale bluish-green shade at the suture of the elytra near the apex. Some examples have the metasternum coppery. One specimen has a little green shade on the abdomen.

MISCELLANEOUS.

Doubly-armoured Herrings. By A. SMITH WOODWARD.

IN his studies of the herrings of New South Wales, Mr. J. Douglas Ogilby* has lately made an interesting observation, of which he does not appear to appreciate the significance. In describing a new species, *Olupea sprattellides*, from the rivers flowing into Port Jackson and Botany Bay, he remarks that it differs from all the

* Records of the Australian Museum, vol. ii. p. 24 (August 1892).

typical members of the genus in exhibiting "a series of scutes similar to those on the abdominal profile between the occiput and the dorsal" fin. He points out, moreover, that this feature is peculiar to "all the freshwater and estuary non-migratory Herrings of the cismontane rivers of the Colony, between the limits of the Richmond River and Botany Bay;" while he finally observes that the presence of the dorsal scutes may perhaps be regarded as separating the species in question from the genus *Clupea*, in which case he proposes the new name of *Hyperlophus*.

If Mr. Ogilby had not shared in that lamentable ignorance of extinct animals so conspicuous in a certain school of zoologists, he might have been spared the discussion of a point that was settled more than fifteen years ago; and, instead of adding to the burden of synonymy, he might have been able to contribute an item to the broad philosophy of the subject. As a matter of fact, the doubly-armoured herrings were discovered in 1877 by Professor E. D. Cope*, who established for them the genus *Diplomystus*—a genus now so widely recognized that it has already found a place in the elementary handbooks†.

Now the great interest of Mr. Ogilby's observation lies in the circumstance that *Diplomystus* is one of the earliest known types of herring, having a very wide range in space during the latter part of the Cretaceous and the early part of the Tertiary period. It was evidently a characteristic fish of those times, and no trace of the genus at a later period seems to have been recorded until the publication of Mr. Ogilby's recent paper. It has been discovered in the Upper Cretaceous of Brazil and of Syria; in the Eocene of Wyoming, U.S.A.; and in the Oligocene of the Isle of Wight. It is most abundantly represented in the Green River Shales of Wyoming‡, and some species exhibit the remarkably forward pelvic fins observed in the new herring from New South Wales. The occurrence of *Diplomystus* at the present day in the freshwaters of Australia, is thus another interesting case of the survival of ancient types in remote places of refuge; and it might be profitable to institute a detailed comparison between the other freshwater Teleostean fishes of Australia and their extinct allies occurring in other parts of the world.

The Development of the Gemmules of Ephydatia fluviatilis, Auct.

By W. ZYKOFF, of Moscow.

While at present engaged in preparing for the press a detailed article on the development of *Ephydatia fluviatilis*, Auct., I see a

* Bull. U.S. Geol. Surv. Territ. vol. iii. p. 808.

† Zittel, Handb. Palæont. vol. iii. p. 276; Nicholson & Lydekker, Palæont. vol. ii. p. 996.

‡ E. D. Cope, Rep. U.S. Geol. Surv. Territ. vol. iii. pp. 73-79, with plates.

possibility of briefly communicating the results at which I have arrived during my investigation of this question.

1. The appearance of the glistening granules (yolk-substance) in the ordinary amoeboid cells must be regarded as the earliest stage in the development of the gemmules.

2. These cells with the glistening granules ("trophophores" of Marshall *) begin to glide towards one another, while they are joined by a fairly large number of ordinary parenchyma cells.

3. Notwithstanding the assertions of Goette †, neither the ciliated chambers nor the canals take part in the development of the gemmules.

4. The cells which have glided together unite, and form a small spherical lump, the central mass of the future gemmule, around which the parenchyma cells group themselves in several concentric rows.

5. The number of the glistening granules in the cells of the central mass increases visibly, so that the ordinary parenchyma cells which were at first observed between those cells completely disappear.

6. The peripheral cells of the parenchyma, which group themselves concentrically around the central mass, gradually assume a clavate form and arrange themselves radially, as was perfectly correctly described by Goette.

7. Moreover these cells group themselves into one, and not into from two to three layers, as Goette maintains, and that, too, not simultaneously over the entire surface of the future gemmule.

8. The lower expanded disciform ends of the clavate cells secrete a chitinoid cuticle, the first internal layer of the future shell of the gemmule, as is quite correctly stated by Goette.

9. There is no "enveloppe primitive" around the central mass of the future gemmule, as described by Wierzejski ‡.

10. Amphidiscs are not formed in the clavate cells of the shell of the gemmules, as is described and figured by Goette §.

11. The amphidiscs appear outside these cells, exactly as described by Wierzejski; and moreover they group themselves in concentric zones around the clavate cells.

12. I have succeeded in observing amphidiscs from the earliest stages of their development until they were fully formed, and I always found them outside the clavate cells.

* W. Marshall, "Vorläufige Bemerkungen über die Fortpflanzungsverhältnisse von *Spongilla lacustris*," Sitzungsberichte der naturforsch. Gesellschaft zu Leipzig, 1884.

† A. Goette, 'Untersuchungen zur Entwicklungsgeschichte von *Spongilla fluvialilis*,' 1886.

‡ A. Wierzejski, "Le développement des gemmules des éponges d'eau douce d'Europe," Archives slaves de Biologie, t. i. 1886, f. 8.

§ Loc. cit. Taf. v. figs. 35 & 36.

13. The amphidiscs gradually penetrate into the layer of the clavate cells, and distribute themselves between them.

14. The cells which are displaced by the amphidiscs emerge upon the surface of the latter, and secrete the second chitinous cuticle, whereupon they atrophy, and the gemmule appears in its completely developed state, as previously described by Goette and Wierzejski.

Finally one little remark in conclusion: Goette's assertion that the clavate cells of the gemmule in process of formation form amphidiscs in their interior, appears to me to be at once improbable, for the very reason that in such a case we would have to ascribe a double rôle to one and the same cell; i. e. the faculty of secreting (1) chitin with their lower flattened end, and that, too, twice over; and (2) silica for the formation of the amphidiscs. So far as I am able to judge, there is no instance of the assumption by one and the same cell of such different chemical functions.—*Zoologischer Anzeiger*, xv. Jahrg., No. 386, March 14, 1892, pp. 95-96 (sent in Dec. 14, 1891).

On the Habits of Gelasimus annulipes, Edw.

By A. ALCOCK, M.B.

Darwin, in the 'Descent of Man,' quotes several observations which illustrate the considerable complexity of life of *Gelasimus*. He refers (2nd edition, pp. 254, 269, and 271) to Fritz Müller's account of Brazilian species of the genus in which the males are more numerous than the females, in which the pugnacity of the males is remarkable, and in which the male exhibits a chameleon-like attractiveness of colour not possessed by the female. He also refers to Milne-Edwards's quotation (*Hist. Nat. des Crustacés*, tom. ii. p. 50), that the male and female of a species of *Gelasimus* live together in one burrow, the mouth of which the male closes with his enormous chela.

The observations which I have to record are on the common species *Gelasimus annulipes*, Edw.

This species lives in vast swarms in "warrens" on the muddy tidal swamps of the Godavari and Kistna, each individual having its own burrow, round which it ranges, and into which it retreats when alarmed.

In the colder months, at any rate, the males far outnumber the females.

In the male alone one of the chelæ is enormously developed. In a fully adult male the length of the large chela is two-and-a-half times the greatest length, and one-and-a-half times the greatest breadth, of the whole body, and 40 per cent. of the entire weight of the animal, and is coloured a beautiful cherry-red fading to a rose-pink,

the rest of the animal being of a dingy greenish-brown colour. I have been able to observe that, whatever other functions the great chela may serve—whether as a stopper to the mouth of the burrow, or as a nuptial support, as some have supposed—it also, in the species under consideration, is (i) a club used in the contests of rival males, and (ii) a signal to charm and allure the females. This last function is particularly apparent. As one walks across the mud one first becomes aware of the presence of these crabs by noticing that the surface of the mud is everywhere alive with twinkling objects of a brilliant pearly pink colour. Carefully watched, these prove to be the enormous chelæ of a crowd of males of *Gelasimus*, waving in the air, each little crab standing at the mouth of its burrow and ceaselessly brandishing its big claw. On closer observation, among every ten or so males a small clawless female may be seen feeding in apparent unconcern. If the female should approach the burrow of a male, the latter displays the greatest excitement, raising itself on its hindmost legs, dancing and stamping, and frantically waving its beautifully coloured big claw. From prolonged watching I feel convinced that the waving of the claw by the male is a signal of entreaty to the female, and I think that no one can doubt that the claw of the male has become conspicuous and beautiful in order to attract and charm the female.

The second function, as a fighting weapon, becomes apparent when in the general tournament one of the rival males approaches too close to another.

The great claw is then used as a club, the little creatures making savage back-handed sweeps at each other. When two males were put into a bucket together the larger immediately gave chase to the smaller, and with one blow swept him off his feet. I did not actually see the rival males seize each other in the conflict, but I have no doubt that they do so, for on going over the field of action I saw several freshly dismembered chelæ lying on the mud. So that the chela is probably used as a shears as well as a club.

It seems likely that the claw primarily became enlarged as a fighting weapon: but this, though it explains its size and weight, is not sufficient to account for its wonderfully conspicuous beauty, which, of itself, must make the little animal, otherwise sombrely coloured in harmony with its habitat, a mark to its enemies.

We can only suppose that the colour and brilliance has been secondarily acquired in order to attract and please the female.—From the *Administration Report of the Marine Survey of India* for 1891-92.

THE ANNALS
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[SIXTH SERIES.]

No. 60. DECEMBER 1892.

LI.—*On a new Spider from Calcutta.* By the Rev.
O. P. CAMBRIDGE, M.A., F.R.S., &c.

[Plate XXII.]

Fam. Theridiidæ.

Genus ARIAMNES, Thor.

Ariamnes simulans, sp. n.

Adult female.—Length $8\frac{1}{2}$ lines; length of cephalothorax 1 line, of abdomen $7\frac{1}{2}$ lines.

Cephalothorax.—Length nearly three times the width; oblong, truncated behind, constricted laterally at the fore extremity of the caput, and sides nearly parallel; of a flattened form; profile-line nearly level; a slight impression behind the eyes and an indentation at the thoracic junction. Its colour is yellowish, with some converging lateral markings forming on each side a broad yellow-brown band.

Eyes at the fore extremity of the caput; four form a large central square, the two anterior eyes being the largest of the eight and seated on tubercles; the lateral pairs are nearer to the hind-centrals than to the fore-centrals, the hind-lateral and hind-central eyes on each side being nearly contiguous to each other.

The *clypeus* is a little prominent at its lower margin, and its height is nearly about half that of the facial space.

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Legs long, slender; relative length 4, 1, 2, 3; those of the first and fourth pairs greatly the longest. The metatarsi are of moderate comparative length. The tibiæ short; their colour is pale yellowish, the femora and tibiæ of the first pair dark yellow-brown; the tibiæ of the second pair pale yellow-brown; they are furnished with hairs only. The *palpi* are short, yellowish; the terminal tarsal claw is rather long, slender, and sharply bent downwards from its base.

Falces small, straight, furnished with bristles in front.

Maxillæ moderately long, rather broadest towards their extremity (where they are obliquely truncated), and a little inclined towards the labium; they are furnished with some black bristly hairs, those on the inner margin of each being the strongest and directed towards each other. The *labium* is small, short, and of a somewhat truncated form. The colour of the falces, maxillæ, and labium is similar to that of the legs.

The *sternum* is of a very elongate heart-shape or subtriangular, its hinder extremity produced between the coxæ of the fourth pair of legs into a truncated point. Its colour is like that of the maxillæ.

The *abdomen* is of a cylindrical form, its posterior extremity produced into a long, tapering, caudal appendage, the length from the spinners to the extremity being at least four times that from the spinners to the cephalothorax; it is of a whitish-yellow hue, with, on the upperside, a central longitudinal silvery line, on each side of which is a yellow-brown stripe, deepening into dark brown at the hinder extremity; the sides of the posterior half of the tail are marked with short transverse (or perpendicular) dark streaks. The extremity of the tail is sharp-pointed and is clothed with a short dark pubescence. The spinners are short, those of the anterior pair strongest. The genital aperture is of characteristic form, being somewhat oblong-oval, divided by a narrow longitudinal septum.

Like some others of a nearly allied genus (*Argyrodes*) this part of the structure was clogged with a kind of resinous looking secretion.

The example from which the above description has been made was kindly sent to me by Mr. D. D. Cunningham, by whom it was found in the Botanical Garden at Shilpur, Calcutta. Its colour when alive is stated to have been vivid green. This I conclude applies to its *prevailing* hue, which has since gone off (as so commonly is the case with green spiders) into dull yellowish. I should, however, suppose that a close

examination in life would show some silvery lines and longitudinal brownish stripes. Mr. Cunningham adds that the resemblance of this spider to a caterpillar is very remarkable; and no doubt in life the caudal prolongation is mobile.

The genus *Ariamnes* has a very wide range; but I have not before seen an example of it nearer the East Indies than Ceylon.

EXPLANATION OF PLATE XXII.

Fig. 1. *Ariamnes simulans*, ♀, enlarged.

Fig. 2. Ditto, in profile, less enlarged.

Fig. 3. Fore part of the caput, showing the position of the eyes.

Fig. 4. Genital aperture.

LII.—*On the Development of the Pedipalpi.* By Dr. A. STRUBELL, of the Zoological Institute of Bonn am Rhein*.

IN view of our scanty knowledge of the natural history of the Pedipalpi, I made it one of my principal tasks during a lengthy sojourn in the Malay Archipelago to follow out in greater detail the development and life-history of a representative of this group of Arachnida, which offers so many points of interest. As the subject of my investigations I selected *Thelyphonus caudatus*, which, while widely distributed in these islands, is particularly common in Java, where I spent several months.

Guided by the erroneous statements of the text-books, according to which the Pedipalpi are viviparous, I commenced by sacrificing a considerable number of specimens without ever discovering embryos in their genital ducts, until towards the end of October I received a female, to the ventral surface of which there was attached a fairly capacious egg-sac.

I am indebted to my little Malay friends for the gradual acquisition of a larger number of eggs, representing a developmental series, which is not absolutely continuous, it is true, but nevertheless embraces the most important stages.

As regards all details of my results I must refer the reader to a fuller account which I hope shortly to be able to lay before those who are interested in the study of the group; I now merely desire to give a brief outline of the development of the external bodily form.

* Translated from the 'Zoologischer Anzeiger,' xv. Jahrg. (1892), nos. 385 and 386, pp. 87-93.

At the period of oviposition the female *Thelyphonus* buries itself fairly deep, often as much as a foot and more, in the earth, and there lays its eggs. Simultaneously with these there issues from the genital aperture a secretion which speedily hardens in the air and surrounds the eggs in the form of a thin-walled transparent sac. This is attached to the ventral surface of the animal, and contains a variable number (fifteen to thirty) of ova.

The ovum, which is oval in shape and rich in yolk, is of the considerable size of nearly 3 millim., and is surrounded by a chorion of a yellowish colour, to which a delicate vitelline membrane is closely attached.

After the formation of the blastoderm there appears near one pole of one side of the ovum, which is somewhat flattened, a roundish white spot, from which, in consequence of a local multiplication of the blastoderm cells, an area which likewise appears white, but is as yet indistinctly defined, soon extends towards the other pole. Upon this disk-shaped region there now appear, as the earliest traces of the future embryo, a series of transverse furrows, which are at first shallow and which apparently arise almost simultaneously and divide the embryonic rudiment into a number of segments. In the first instance seven such divisions are distinguishable. After the first and largest section—the cephalic plate, which, however, is not yet sharply circumscribed,—the second is constituted by the segment which furnishes the pedipalpi, and this is succeeded posteriorly by four other segments, from which the ambulatory limbs subsequently proceed. Finally the seventh and last section, which, in contradistinction to the other fillet-shaped sections, is semicircular in shape, with its periphery directed forwards, may in consequence of its function be termed the abdominal plate. All these segments are primarily unpaired structures. While, however, they become further and further separated from one another, there soon appears in the median line a shallow and narrow longitudinal groove, which divides the whole of the segments, with the exception of the abdominal plate, into two symmetrical halves. This median furrow proceeds from the posterior towards the anterior end of the embryo. The last four thoracic segments are the first to divide, and these are subsequently followed by the segment which gives rise to the pedipalpi, and thereupon also by the eighth division, the segment of the chelicerae, which has in the meantime become separated off from the cephalic plate, which likewise divides into two apical lobes. While this process is taking place the unpaired abdominal plate increases in breadth; at its

lateral margins there appear distinct depressions, which, becoming deeper, give rise to the first pair of the abdominal segments. This is succeeded by the second pair, which are produced by further constriction. Owing to the fact that the abdominal segments become intercalated between the abdominal plate and the last thoracic segment, and that, in consequence of the lateral expansion of the median groove, the posterior thoracic segments separate more and more from one another, the primitive streak gradually loses its disk-like form, and, while it now becomes more sharply marked off from its environment, assumes the shape of a pear. At this period the earliest rudiments of the appendages become visible upon the several thoracic segments. The latter have in the meantime increased in extent and have become fused together at their margins. The appendages appear near the middle of the segments as small knob-shaped prominences, and the pedipalpi as well as the ambulatory limbs precede the cheliceræ in development. Meanwhile the abdominal segments have further increased by the process of splitting off from the abdominal plate, and hand in hand with this the median groove, which may now be more appropriately termed the median area, has also expanded still more in its posterior section.

It naturally follows that with this process the primitive streak once more becomes changed in appearance. We may now compare its form with an isosceles triangle, the apex of which is occupied by the cephalic plate, while the two widely divergent halves of the primitive streak form the sides, and the base is represented by the abdominal segments, which adjoin one another almost in a horizontal plane.

Simultaneously with the appearance of the appendages the rudiments of the nervous system arise as two rather broad bands, which run on the inside of the thoracic segments as far as the abdomen, and soon divide into a series of six pairs of ganglia, in correspondence with the number of the segments. These two bands come into contact with one another at the cephalic plate, where the mouth has already become visible as a small pit between the apical lobes.

No material change in the relative position of the primitive streak and yolk has taken place during this period. In consequence of the longitudinal growth of the embryonic rudiment the cephalic plate has indeed curved over slightly towards the dorsal side; but so striking a flexure as has been frequently observed in the true spiders is never found in *Thelyphonus*. The ventral surface of the ovum, upon which the primitive streak lies in its entire extent, still exhibits a

pronounced convexity, which does not become incavated until later.

The changes which now take place and are externally visible are primarily exhibited in the further development of the segments of the body which have already been mentioned. In the first place the abdomen again increases considerably in size. While more segments are continually separated off from the median unpaired abdominal plate, the latter with its adjoining abdominal divisions moves out from its previous horizontal position, and gradually projects forwards at an acute angle.

The formation of the twelfth pair of abdominal segments completes the series; the abdominal plate then lies as a terminal piece at the tip of the abdomen, and from it the caudal filament is subsequently developed. It is especially worthy of remark that provisional appendages, such as those with which we are acquainted in the case of the scorpions and the true spiders, are not to be found at any period upon the abdominal segments of *Thelyphonus*. On the other hand, small thickenings appear at an early period on the inner margin of the several segments, and, gradually becoming more sharply defined, represent the ganglia of the abdominal portion of the ventral chain.

If we now take a lateral view of the ovum, we observe that the upper portion of the ventral surface has become flatter, while the posterior division projects somewhat towards the protruding abdomen. The development of the embryo now makes rapid progress. Two semicircular pits appear at the hinder margins of the apical lobes. The labrum becomes visible above the mouth, while the labium arises as a narrow protuberance at its lower border. In proportion as the brain continues to develop the further forward does the mouth advance, until it finally comes to lie between the chelicerae, which are situated close to one another. The limbs, too, have in the meantime increased in length and their segmentation is already visible, although not yet distinct.

Simultaneously with this a peculiar hemispherical structure comes into view between the first and second ambulatory limb. It first appears as a small lateral prominence at the base of the second limb, which is still knob-shaped; but it soon becomes constricted off, and then assumes the above-mentioned position. I am unable to make a definite statement as to the significance of this organ. The fact that at a spot on the inner side of the chorion corresponding with this body a brownish substance is excreted, which projects like a tooth between the two limbs, seems to betoken a secretory

function. This structure is likewise found in *Phrynus*, only in this case it does not change its original position, but remains at the base of the second limb.

When the extremities have already attained a considerable length, and before all the other organs which have just been mentioned have arrived at the stage of development which has been described, there begins to be noticeable upon the ventral surface a slight groove, which gradually becomes deeper and finally leads to a separation between the cephalothorax and the abdomen. The former at last bends so far towards the abdomen that the extremities lie close to the sides of the latter. At this period there also takes place the closure of the dorsum. Shortly after the formation of the rudiments of the appendages there are already to be observed on the outer side of the two halves of the primitive streak small quadrate areas which adjoin one another, and in the course of the development grow out laterally, to subsequently unite in the median line of the dorsum with the formation of the heart. This closure takes place very rapidly, though we are able to observe that it proceeds from in front towards the rear. It is only at this stage, when the dorsal sides have grown together, that the final development of the ventral surface likewise takes place. Hitherto the six pairs of thoracic ganglia lay, in accordance with their origin, at the sides of the widely divergent halves of the primitive streak, separated from one another in the shape of a bifurcate fork, open posteriorly; and in the same way until now the two abdominal ganglionic cords had preserved their position unchanged at the boundary between the dorsal and ventral surfaces. These also now travel towards the median ventral line of the abdomen, and there unite to form a continuous chain.

With this the development of the embryo is essentially complete. It only remains to be mentioned that some time previously a delicate cuticular envelope was formed, which clothes all parts of the body; upon this envelope we observe at the base of each of the ambulatory limbs, as well as of the pedipalpi and chelicerae, a pointed thorn of chitin, which is destined to facilitate the process of hatching. With the help of these egg-teeth the embryo now breaks through the shell, stripping off its first cuticular coat in so doing, and attaches itself firmly to the dorsal or ventral surface of the mother, by which it is still carried about for some time longer.

The just-hatched young at first exhibits only very slow awkward movements, and is so remarkably different from the

adult *Thelyphonus* in appearance that it may well be termed a larva with some degree of justice.

In colour it is yellowish white. The abdomen, which is cylindrical in shape in consequence of the still abundant yolk which is stored up within it, materially exceeds the cephalothorax in volume. Upon the cephalothorax are situated three pairs of pale red, tube-like, ambulatory limbs, which exhibit no distinct segmentation, and at their tips instead of the claws bear adhesive disks of considerable size. The pedipalpi, like the unsegmented caudal filament, are still relatively short; their terminal joint, which in the adult is developed into a powerful chela, is still unpaired. The eyes still lie beneath the larval skin, while the lung-sacs do not yet communicate with the exterior.

Particularly striking, however, is the primitive condition of the ventral nerve-chain, which is distinctly perceptible beneath the thin chitinous covering; for while the adult animal exhibits only a single large ganglion in the cephalothorax, from which, besides a few lateral branches, a simple central main cord runs through the abdomen, to expand posteriorly into a small ganglion, the larva still possesses a completely segmented ventral chain. The six pairs of ganglia of the cephalothorax are still sharply distinguishable from one another; the abdominal section consists of ten pairs of ganglia, of which the first six pairs are connected with one another by transverse and longitudinal commissures, while the four terminal ones, which are more closely united together, constitute a common but still segmented mass.

It is only during this larval period that the development of the organs is completed in the form in which we find them in the adult *Thelyphonus*. While this is taking place the larva remains constantly upon the body of the mother, and in the meantime consumes the yolk-material which it has brought with it. After some time a second ecdysis takes place, whereupon the creature, now equipped with all the attributes of the parent, leaves its mother, henceforth to seek its food independently in the same pugnacious manner.

It will be seen from what has been stated above that the mode of development of *Thelyphonus* exhibits a greater agreement with that of the true spiders than with that of the scorpions. The pronounced divergence of the two halves of the primitive streak and the other phenomena connected with this are characters which have to be taken into consideration in this connexion equally with the entire absence of embryonic membranes.

In the detailed paper it will be my task to enter more fully

into the question of affinities, and with the help of figures to give a more exact account of the development of the bodily form, of which the above is only a cursory sketch, as well as of the organogeny.

LIII.—*Limax maximus*, L., and its Variety *cinereo-niger*, Wolf. By WALTER E. COLLINGE, Demonstrator of Biology in Mason College, Birmingham.

As there seems to be a general misunderstanding as to what the *L. cinereo-niger* of Wolf really is, notwithstanding a number of important papers that have been written upon its anatomy &c., and having had the opportunity of examining a series of British examples, I desire to make a few remarks upon the same, from which it will be evident that this slug is simply one of the many colour-variations of the well-known *L. maximus*, L. It is the more important that this should be done as Mr. Roebuck * has stated that "it [*L. cinereo-niger*] is now separated by the best continental authorities" and "that there are also important differences between the two species in the genital apparatus." It is upon this statement that its right to rank as a species is based in this country. Now it is to be greatly regretted that Mr. Roebuck has never thought it worth while to point out these *important differences* in the genital apparatus, for Simroth †, who has described the anatomy, fails to see any difference in it from *L. maximus*. Dr. Scharff ‡, who has still more recently examined the anatomy, says, "I found no difference anatomically between it and a typical *L. maximus*, except in the origin of the retractor muscle of the penis" §.

In face of these statements, to which I have quite recently drawn Mr. Roebuck's attention, he still || classes it as a species, adding a note to the effect "that it is at least entitled to subspecific rank," its external characters being "so distinct and unmistakable," not a word being said as to the previous-named *important differences* in the reproductive organs.

* Journ. Conch. vol. iv. p. 38 (1883-85).

+ Zeitschr. f. wiss. Zool. vol. xlii. (1855).

‡ Trans. Royal Dublin Soc. vol. iv. ser. 2, p. 518 (1891).

§ Variations in the point of the origin of the retractor muscles are one of the commonest, and are met with in typical examples of all species of slugs.

|| Journ. Conch. vol. vii. (1892).

The specimens I have examined were mostly full-grown slugs; and after thirteen dissections the only difference I was able to discover was one similar to that pointed out above by Dr. Scharff, viz. in the point of the origin of the retractor muscle of the penis. The reproductive, digestive, and nervous systems all support Simroth's statement that this slug is but a colour-variation of *L. maximus*.

Any malacologist possessing a knowledge of the colour-variations of even our British slugs cannot, I think, consistently, and certainly not scientifically, found species upon the same. Jourdain * has stated that such differences in the Limacidæ as general form, coloration, structure of the shell, jaw, &c. are characters which vary with age and habitat, and that for specific distinction recourse must be made to the internal anatomy.

Of late I have frequently drawn attention † to the importance of a knowledge of the anatomy of the Mollusca, and it is to be regretted that Mr. Roebuck should, in the face of statements from able anatomists such as I have mentioned, persist in confusing an already very complicated subject.

LIV.—*Descriptions of Three new Species of Butterflies captured by Mr. D. Cator in British North Borneo, in the Collection of Mr. Grose Smith.* By H. GROSE SMITH.

Papilio Catoris.

Male.—*Upperside.* Both wings white, with black veins and markings. Anterior wings with four irregular oblique bars crossing the cell and extending to the costal margin, the first and third bars interrupted; beyond the cell is a large black irregular patch extending above the lower discoidal nervule and below the uppermost median nervule; broad black streaks extend along the middle and lower median nervules and the submedian nervure, the two lowest streaks being connected by a large black quadrangular spot; between the veins is a curved submarginal row of conical black spots, the uppermost being the largest and protracted inwardly. Eight triangular black spots at the ends of the veins, connected with each other on the margin, the two uppermost at the apex being confluent; a black line on the inner margin widest near the base.

* 'Comptes Rendus,' vol. ci. p. 963 (1885).

† Cf. Ann. & Mag. Nat. Hist. vol. ix. p. 308 (1892); 'The Slugs of the British Isles,' p. 1 (1892); 'The Conchologist,' vol. ii. p. 56 (1892).

Posterior wings with the veins from the base to near the submarginal row of spots broadly black; the cell is crossed from near the middle of the subcostal nervure to near the end of the median nervure by a broad black line; between the uppermost and middle median nervules, at their junction with the median nervure below the cell, is a large oval black spot; the broad black streaks along the lowest median nervule and the submedian nervure curve towards and join each other at their outer end, forming a loop; there is a submarginal row of six subconical spots, that nearest the costal margin the longest and largest, the spot nearest the anal angle rectangular; at the anal angle is an irregular subcaudate black bar, surmounted by a pale yellowish space, above which is a narrow black line; the ends of the veins are broadly tipped with greyish-black markings, which join each other and form an irregular grey band on the margin, which is emarginate.

The underside resembles the upperside, but the marginal spots are smaller and not connected with each other.

The *female* resembles the male.

Expanse of wings $4\frac{1}{2}$ inches.

Hab. Pingas and Penungah, North-east Borneo.

This remarkable butterfly, which is named after its captor, is intermediate between *P. idæoides*, Hewitson, and *P. Deleserti*, Guérin.

Appias flavius.

Male.—Upperside. Resembles *A. nero*, Fabr., but is more yellowish orange, the veins are the same colour as the wings, not black as in *A. nero*, nor is there any dusky shading towards the margins.

Underside. Anterior wings paler, and posterior wings yellower than on the upperside. The dusky indistinct submarginal bands which cross the disk of both wings of *A. nero* are absent on the anterior wings, and on the posterior wings are represented by a dusky patch beyond the cell.

Female.—Upperside. Both wings paler yellowish orange than in the same sex of *A. nero*. On the anterior wings the discocellular nervules, and the median nervure from the base to its junction with the lowest median nervule are narrowly black, all the rest of the veins in the centre of the wings being flavous; the sinuate dark band which crosses the disk of the female *nero* is in *A. flavius* narrower, and not interrupted between the lowest median nervule and the submedian nervure; the space towards the base of both wings which is irrorated with dusky scales is more restricted than in the female *nero*.

Expanse of wings $2\frac{1}{2}$ inches.

Hab. Taganac Island, North-east Borneo.

From a good series of this insect, in which the characteristics above described are uniform, I am induced to consider this variety as worthy of description. The ordinary form of *A. nero* was not captured in the island. Some of the male specimens are more red than others, a variation which also occurs with *A. nero*, but in all of them the veins are the same colour as the rest of the wings. In coloration it approaches the variety of *A. nero* from the Island of Palawan, but it is less bright, though brighter than *A. zarinda*, Boisduval, from Celebes.

Elymnias borneensis.

Male.—*Upperside.* Anterior wings dark brown, brightly suffused with purple, with three pale blue elongate spots situate between the discoidal and upper median nervules; the purple reflection extends to the posterior angle, but not quite to the apex of the wings. Posterior wings brown, slightly suffused with purple over the whole extent of the wings.

Underside. Both wings resemble those of *penanga* and *sumatrana*, but are darker, and on the posterior wings there is no submarginal row of spots.

Female.—*Upperside.* Anterior wings greyish brown, faintly with dull blue at the base; an oblique irregular ill-defined greyish-white band from the middle of the costal margin to near the middle of the hind margin, and a similar band extending into the cell, about its middle, and over the space between the submedian nervure nearly as far as the middle median nervule. Posterior wings greyish white, slightly tinged with pink, with a broad greyish-brown streak from the base along the upper subcostal nervule and thence round the outer margin, where on its inner edge the streak is sinuate on the veins.

Underside. Both wings brown, irregularly mottled with grey, the grey bands and patch on the upperside being indistinctly represented.

Expanse of wings $2\frac{3}{8}$ inches.

Hab. North-east Borneo.

This species is near to *E. penanga*, Westwood (*mehida*, Hew.), but the male differs in having only three instead of five blue spots on the anterior wings, and the female is quite distinct from the female of that species.

In the Hewitson Collection at the British Museum the male of this species is placed with specimens of *E. mehidu*, and the female is unnamed.

LV.—*On the Morphology and Phylogeny of Insects.*
By N. CHOŁODKOWSKY*.

"Comparative anatomy will have to confine itself more and more to the raising of problems, while the exact formulation and solution thereof is the province of embryology."—KLEINENBERG.

AMONG the embryological phenomena which are of importance for phylogenetic deductions the segmentation of the germinal streak certainly occupies a prominent position. This will therefore be the appropriate place for the discussion of the question as to the number of the segments of the germinal streak and of their paired appendages. I shall leave out of the question the so-called primary segmentation observed by Ayers, Graber, and Nusbaum—in the first place because it has as yet been but very little investigated, and secondly because I doubt that this primary segmentation was of great phylogenetic importance. For it is quite possible that the early division of the germinal streak into four sections is occasioned by similar causes to those which are responsible for the early appearance of bilateral symmetry in Vertebrates and Arthropods or of the shell in Mollusks, *i. e.* by reaction of the definitive shape of the animal upon the form of the embryo. It may be added that as long ago as 1870 Metschnikow described a similar primary segmentation in *Scorpio*, in which the germinal streak at first divides into three large sections.

The total number of the segments of the germinal streak of Insects is stated by authors to be from sixteen to eighteen, and is said to be at any rate not more than eighteen. The foremost segment, which bears the antennæ, is universally considered to be pre-oral, while the remaining segments are stated to form the primary trunk; the first three of these belong to the head, the fourth to the sixth body-segments to the thorax, and the seventh to the seventeenth to the abdomen. The last (eleventh) abdominal segment is not considered to be entirely homologous with the other metameres, and is termed the "end-segment." The above is the prevalent conception of the Insectan germinal streak at the present time, and in accordance with this are also interpreted the

* Translated from the 'Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg,' vii^e série, t. xxxviii. no. 5, pp. 80–101 (St. Petersburg, 1891); being the concluding portion of a memoir by the same author entitled "Die Emlryonalentwicklung von *Phyllodromia* (*Blatta*) *germanica*" (*ibid.* pp. 1–120, with six plates).

morphological value of its appendages and their homologies with extremities of other Arthropods. Herein the homology of the anterior end of the embryo in all Arthropods is assumed; the homology of the posterior end is out of the question, for the number of the abdominal segments varies greatly in different Arthropods.

In setting up homologies of the parts of the body and the extremities the question of the value of the foremost cephalic appendages is of special importance, for it is precisely on the basis of the conception of these appendages that attempts have been made to divide the type of the Arthropods into two, three, or four subtypes. In the critical examination of the morphological value of the appendages the innervation of the latter is also taken into account, and justly so. I have no intention of enumerating here the attempts which have been made to homologize the cephalic appendages of Arthropods, since this would lead me too far; it will be sufficient to allude to the fundamental principles of these homologies, which have been accepted by the majority of authors as dogmas. Thus it is considered to be an established fact that (1) the head of Insects consists of four metameres; (2) the antennæ of the Tracheata, partly by reason of their innervation from the supra-oesophageal ganglion, are to be regarded as pre-oral appendages; (3) the chelicerae of the Arachnida (which were formerly held to be homologues of the Insectan antennæ) are homologous with the mandibles of Insects, since they are originally innervated from a post-oral ganglion, which only subsequently fuses with the supra-oesophageal ganglion; (4) the first (anterior) pair of Crustacean antennæ is homologous with the antennæ of Insects, since to the second pair of antennæ there corresponds a special pair of ganglia which is originally post-oral, though it subsequently fuses with the supra-oesophageal ganglion.

Certain highly important facts have recently become known which, in my opinion, render the justice of the above view of the cephalic appendages of Insects very doubtful. In Chapter IV. of this memoir (p. 43) I have alluded to the fact that the conjecture has already been expressed by Tichomirow * that the Insectan head perhaps consists of six metameres; further, that in the case of *Chalicodoma* even as many as seven embryonic cephalic segments are supposed to exist by Carrière, and that I myself on the basis of my own investigations am inclined to consider that not less than six segments are present in the head of Insect embryos. The

* A. Tichomirow, 'Entwicklungsgesch. des Seidenspinners im Ei' (Moskau, 1882): in Russian.

highly interesting facts communicated by Carrière are unfortunately stated only too briefly; besides this, his figures are somewhat indistinct, and, what is especially to be regretted, his paper contains no transverse sections from the cephalic region such as would make it clear how the seven pairs of ganglia, to which the author alludes, are related to the cephalic extremities. Carrière considers the ganglion frontale to be the nerve-centre of the first (foremost) cephalic segment; as I have already stated, I do not think it possible to homologize the sympathetic ganglia with the centres of the central nervous system. It is further to be remarked that, according to Carrière, the antennary segment is pre-oral, which, however, does not harmonize with his own figures. Carrière states that four pre-oral segments are present, so that only the mandibular and maxillary segments are post-oral. According to my view, however, the homology of the Insectan antennæ with the rest of the ventral extremities is placed beyond all doubt both by their post-oral position, which has been conclusively proved in the case of many Insects, and also by the presence of a mesodermal somite belonging to the antennæ. I am therefore constrained, at least until the appearance of the detailed paper by Carrière, to rely solely upon my own observations upon the development of the cephalic nervous system in *Phyllodromia* and upon Tichomirow's statements as to the embryonic cephalic appendages in *Bombyx mori* (which I find to be confirmed by my own observations upon *Gastropacha pini*). It seems to me that it is sufficiently clear from these observations that, if there is any homology at all between the antennæ of Tracheata and Crustacea, the antennæ of Insects can only correspond to the second pair of antennæ of Crustacea, since the antennary ganglia (the embryonic antennary lobes) of Insects strictly belong to the primary trunk, and, just as in Crustacea, do not become fused with the rudiments of the pre-oral ganglia until later. For the same reason I consider that the chelicerae of Arachnids are also homologous with the Insectan antennæ. As to further homologies of the mouth-parts and the other extremities of Arthropods, I consider it to be quite impossible to give a comparative table of them at the present time, as has become the usual practice. Such tables are in my opinion premature, since the question of the composition of the Arthropod head proves to be much more complicated than is generally supposed. The very fact, observed by Tichomirow, Bütchli, Carrière, and myself (in *Gastropacha pini*), that small appendages are situated between the antennæ and mandibles, is sufficient to warn us to be cautious and that we

should do better to wait a little before we homologize the mouth-parts of Myriapods, Arachnids, and Insects, not to mention Crustacea. For our knowledge of the development of Myriapods is as yet altogether too scanty, and even the embryology of Insects and Spiders needs completion. Under such conditions it would be far too daring to attempt an homologization of the mouth-parts of Arthropods at present. One thing I believe is certain, namely that the antennæ of Insects, and in all probability of the Tracheata in general, are true homologues of the appendages of the trunk, and therefore do not correspond to the pre-oral antennæ of *Peripatus*. It is also hardly open to doubt that the group ACERATA (Pœcilo-poda and Arachnida) established by Kingsley does not correspond with its name, for there exists no reason at all for considering the chelicerae to be not homologous with the Insectan antennæ. There is also no justification for Lang's proposed division of the Tracheata into ANTENNATA (Myriapoda and Hexapoda) and CHELICERATA (Arachnida), since the Arachnida, on the basis of the development of the cephalic extremities, are not separable from the Antennata.

Among other appendages of the germinal streak of Insects those belonging to the abdomen are also very interesting, and I will now discuss them somewhat more in detail. As we have seen (Chapter III.) the embryo of *Blatta germanica* possesses eleven pairs of abdominal appendages, which, according to all appearance, are completely homologous with the thoracic legs. It is here my intention to consider those abdominal appendages which persist for a longer time in the post-embryonic development, such as the pro-legs of caterpillars and Tenthredinid larvæ, the abdominal appendages of the Thysanura, &c.

With reference to the abdominal appendages of *Campodea* and *Machilis*, the prevalent view for a long time was that they are homologous with the true legs. Only a few investigators, such as Burmeister*, declared against this theory. Considerable doubt has recently arisen as to the significance of these appendages as rudiments of legs; for certain authors believe that they correspond not to the legs, but to the coxal appendages, which are also present upon the thoracic legs. If this view, which is based exclusively upon anatomical facts, is correct, abdominal legs provided with coxal appendages must nevertheless exist in embryonic life in the case of *Machilis* and *Campodea* also and be able to subsequently disappear, leaving only their coxal appendages behind. Con-

* Burmeister, 'Handbuch der Entomologie,' Bd. 2, 1838, p. 454.

siderable attention has been bestowed upon the abdominal appendages of Insects by Dr. Haase, who recently published a detailed treatise* upon this subject. Unfortunately Dr. Haase's very interesting paper takes zoographical and anatomical facts too exclusively into consideration; it pays but little attention to comparative embryology. In my opinion, however, it is altogether impossible to set up homologies without constant reference to the facts of embryology. For instance, while Haase decides the question as to the abdominal styles of *Machilis* and *Campodea*, which is altogether in dispute, because it has not yet been embryologically investigated, by declaring them to be coxal appendages, he also assigns to the same category the so-called styli of the Orthoptera, whilst partly appealing to my own investigations, which are stated by him to show that the styli "only arise from dermal papillæ considerably later than the rudiments of the legs, and even than those of the cerci." I am bound to declare that neither from my figures† nor from my preparations, which were at his service, was it possible for Dr. Haase to draw such a conclusion. The styli do not arise from "dermal papillæ," but consist, like the rest of the extremities, of ectoderm and mesoderm, and their cavity communicates with that of the somite to which they belong. Moreover, it is indeed true that they arise some time after the thoracic legs, but not later than the cerci. The truth may possibly be that for the earliest rudiments of the cerci Haase mistook the caudal lobes, which subsequently undergo degeneration and are almost entirely absorbed in the formation of the cerci, as has already been described by Tichomirow in the case of *Bombyx mori*. The sole difference between the styli and the cerci on the one hand, and the rest of the abdominal appendages on the other, consists in the fact that the latter soon disappear, while the former persist in post-embryonic development. I have therefore no doubt that the styli in *Phyllodromia* (and, as is highly probable, in all Orthoptera) are genuine rudiments of limbs, and do not correspond to the abdominal styles of *Machilis* and *Campodea*, in the event of Haase's view as to the value of the latter as coxal appendages being correct.

It is true that with regard to the cerci certain doubts

* Haase, "Die Abdominalanhänge der Insekten mit Berücksichtigung der Myriapoden," *Morphol. Jahrbücher*, Bd. xv., 1839, pp. 331-436, Taf. 14, 15.

† N. Cholodkowsky, "Studien zur Entwicklungsgeschichte der Insekten (u. Nachtrag dazu)," *Zeitschr. f. wiss. Zool.* Bd. 48, pp. 89-100 and 301-302, Taf. viii.

exist, which, however, are perhaps more apparent than real. Thus the last (tenth) abdominal segment of *Machilis* bears three long-jointed appendages which are similar to one another. If the two lateral appendages correspond to the cerci of the Orthoptera, which is hardly open to doubt, what is the value of the third median appendage? Haase expresses the conjecture that this represents nothing else than a much elongated and secondarily jointed end-segment (anal covering-piece). This explanation is a very plausible one. The best proof of the fact that the segments of the Insect body may exhibit secondary (superficial) segmentation is furnished by certain larvæ, such as, for instance, that of *Chardiophorus*, which exhibits twenty-six apparent segments (behind the head), that of *Thereva*, in which seventeen apparent abdominal rings are visible, and others (according to Perris). But it is self-evident that a definite judgment upon the median terminal filament of *Machilis*, Ephemeriðæ, &c. cannot be pronounced until the embryology of these forms has been investigated. Another very interesting example is furnished by the genus *Tridactylus*, Oliv. (*Xya*, Latr.), in which the tenth abdominal segment bears two pairs of cerci (ventral and dorsal). In this case the ventral cerci perhaps correspond to the rudiments (which in other Insects, as also in *Phyllodromia*, undergo degeneration) of the tenth embryonic abdominal segment, which subsequently fuses with the eleventh. This question has likewise to be decided by embryological investigation.

Thus we see that the difficulties as to the interpretation of cerci, to which reference has been made, are at any rate capable of more or less plausible explanations; on the other hand, the development of the cerci in *Phyllodromia* shows so clearly that they are equivalent to the antennæ and the rest of the ventral extremities that I can discover no reason whatever for not regarding them as homologous with the thoracic limbs. In any case such an interpretation of the cerci appears to me to have a much better foundation and to be less arbitrary than, for instance, the comparison with the furcal appendages of *Apus* or the anal feelers of *Polychætes* (Haase).

Of the highest interest are the ventral appendages of Poduridæ, that is to say the springing-fork and the so-called ventral tube. Haase considers the fork to be equivalent to the abdominal styles of *Machilis*, and therefore not homologous with the limbs. But it has already been shown by Uljanin* that the springing-fork of the Poduridæ arises from

* B. Uljanin, "Beobachtungen über die Entwicklung der Poduren,"

two abdominal appendages, which are in every respect similar to legs, so that their homology with the thoracic limbs is hardly open to doubt. With regard to the ventral tube it is supposed by Haase that this corresponds to the "ventral sacs" of *Machilis*, *Scolopendrella*, *Campodea*, &c., wherein he again disregards embryological facts; for it was proved by Uljanin that the ventral tube develops from two anterior abdominal appendages, which are quite similar to, and almost certainly homologous with, the thoracic legs, while the ventral saccules, *e. g.* in *Scolopendrella*, occur on the same segments as those on which limbs are also present, and therefore cannot be homologous with the legs. With regard to the pyriform appendages of the first abdominal segment of certain Insect embryos Haase expresses himself very vaguely; for while he considers their homology with the ventral saccules to be also somewhat doubtful, he nevertheless believes that they possess a similar (respiratory) function, and that "it is probably a latent ancestral character that allows these structures, which are so entirely analogous to one another, to arise once more at the same places." Embryology, however, shows most distinctly that the pyriform appendages develop from typical leg-like structures, indisputably homologous with the thoracic limbs, and that therefore there can be no question of homology with the ventral saccules of Myriapods and Thysanura. As to the function of the pyriform appendages, this is in all probability the same as that of the ventral tube of the Poduridæ, which, according to Haase, climb up glass by the help of this organ (though they are also capable of doing so without its assistance). That the pyriform organs are adhesive was the conclusion previously arrived at by Rathke*, according to whom in extracting embryos of *Gryllotalpa* from the embryonic envelopes the "mushroom-shaped bodies" are easily detached and remain sticking to the envelopes †. The latest statements of Wheeler ‡, Graber §, and Nusbaum ||

Nachrichten d. Moskauer Gesellsch. d. Liebhaber von Naturwissensch. &c., 1875, Bd. 16, Lief. 3, pp. 1-10, Taf. iii.-v. (in Russian).

* Rathke, "Zur Entwicklungsgeschichte der Maulwurfsgrille," Arch. f. Anat. u. Physiol. 1844, pp. 27-38, Taf. ii. figs. 1-5.

† Rathke was also the first to observe the faceted surface of these appendages.

‡ W. M. Wheeler, "The Embryology of *Blatta germanica* and *Doryphora decemlineata*," Journal of Morphology, vol. iii. 1889, pp. 298-374, pls. xv.-xx.

§ Graber, "Ueber den Bau und die phylogenetische Bedeutung der embryonalen Bauchanhänge der Insekten," Biol. Centralbl., Bd. ix. 1889-1890, pp. 355-363.

|| J. Nusbaum, "Die Entwicklung der Keimblätter bei *Melos proscarabæus*," Biol. Centralbl., viii., 1888, p. 449.

also agree with this. But if these organs exhibit a glandular character it does not yet follow that they have a respiratory function. New experiments conducted by Haase upon the ventral sacculæ and the ventral tube prove that these organs in the expanded and extended condition become filled with blood; this takes place especially in a damp and warm atmosphere. Haase concludes from this that they represent gills. It is not impossible that in certain cases the pyriform abdominal appendages of Insect embryos may also subserve the respiratory function; such is certainly not the case in *Blutta germanica*, however, for here the appendages in question contain no cavity whatever. However this may be, embryology shows us quite unmistakably that the original shape of these appendages is leg-like, and that therefore their primitive function was an ambulatory one; it is not until later that they change their form and become, owing to enormous development of the ectoderm cells, glandular adhesive organs; if at the same time a cavity is preserved in them, they may perhaps to a certain extent also assume the function of respiration. It is very interesting to compare these glandular appendages with the abdominal appendages of the Spiders, which become spinnerets. In the Spiders, according to the beautiful observations of Morin *, at the tip of the appendage a glandular depression (the future spinneret) is formed, which is altogether similar to the depressions described by Nusbaum † in the abdominal appendages of *Melos* ‡.

I now proceed to the consideration of the other abdominal appendages which persist in post-embryonic life. To this category belong both the so-called pro-legs of Lepidopterous and Tenthredinid larvæ, and also the abdominal appendages of other Insect larvæ. In the paper which has been cited above Herr Haase has collected a large number of facts bearing on this point, so that I can dispense with their enumeration. I therefore address myself at once to the abdominal legs of caterpillars.

As is well known, as long ago as 1869 the view was expressed by Brauer § that multiplied insect larvæ are to be

* Morin, "Zur Entwicklungsgeschichte der Spinnen," Biol. Centralbl., vi. Bd., 1887, pp. 658-663. (Also in Russian, with plates: Odessa, 1887.)

† *Loc. cit.*

‡ Whether the eversible caruncles described by Gerstaecker ("Ueber das Vorkommen von ausstulpbaren Anhängen am Hinterleibe von Schaben," Archiv für Naturgeschichte, 27 Jahrg., i. Bd., 1861, pp. 107-115) in *Corydia* also belong here is very doubtful.

§ Brauer, "Betrachtungen über die Verwandlung der Insekten im Sinne der Descendenz-Theorie" (with one plate), Verh. zool.-bot. Ges. Wien, Bd. 19, 1869, pp. 299-318.

regarded as secondary forms which are derivable from the primary *Campodea*-like larva and have arisen by the process of adaptation. The theory started by Brauer was supported by Packard* and Lubbock†, and has been the generally accepted one hitherto. At the time when Brauer published his little paper, which has met with so much success, our knowledge of the embryonic development of insects was still very scanty, since Kowalevsky's‡ memoir, by which new paths were opened out, and Bütschli's§ paper, in which the presence in an insect embryo of numerous abdominal appendages was asserted for the first time, were not published until 1871 and 1870 respectively. This, as it seems to me, explains the favourable reception of Brauer's hypothesis, with which, as I shall show, the embryological facts are decidedly at variance. That this hypothesis has hitherto maintained its importance for the majority of zoologists and is constantly repeated in text-books is in my opinion accounted for by the insufficiency of the embryological statements on the question, as also by the fact that certain valuable papers are incompletely known; thus, for instance, Tichomirow's memoir upon *Bombyx mori*, because it is written in Russian, has only become more fully known to foreign students within the last few years. But although I will not deny that the embryology of Insects, and of Lepidoptera in particular, still requires completion, nevertheless I venture to assert that precisely on the subject of the abdominal appendages our knowledge is already satisfactory. The facts bearing upon this were communicated by Kowalevsky, Tichomirow, and Graber. Kowalevsky, who, *inter alia*, investigated the embryology of *Smerinthus populi*, figures ten pairs of perfectly distinct abdominal appendages upon the germinal streak of this moth. Tichomirow describes and figures in *Bombyx mori* small but "distinct" appendages on all the abdominal segments with the exception of the first; in subsequent stages (when the cephalic segments become fused together) only the appendages of the third to the sixth segments and of the eleventh segment (which afterwards fuses with the tenth and ninth) are preserved and undergo further development, while the

* Packard, 'The Ancestry of Insects' (Salem, 1873).

† Lubbock, 'Ursprung u. Metamorphosen der Insekten' (Jena, 1876).
['On the Origin and Metamorphoses of Insects' (London, Macmillan and Co., 1883).]

‡ A. Kowalevsky, "Embryologische Studien an Würmern und Arthropoden," Mém. Ac. Sc. Pétersb. 7, xvi. no. 2, 1871, 70 pp., 12 plates.

§ Bütschli, "Zur Entwicklungsgeschichte der Biene," Zeitschr. f. wiss. Zool. Bd. 20, 1870, pp. 519-564, 4 plates.

rest atrophy and finally disappear without leaving a trace behind. Graber studied *Gastropacha quercifolia*, in which moth we are told that the abdominal appendages do not appear until a relatively very late period (when the four cephalic segments have become fused together), and then only on those segments on which they are also present in the caterpillar; so that the series of embryonic abdominal appendages is not a continuous one. From this Graber concludes, erroneously referring to Tichomirow (the Russian text of Tichomirow's paper was clearly unintelligible to him), that the pro-legs of caterpillars are not homologous with the thoracic legs, and represent secondary formations. At the same time he is nevertheless prepared to allow that if a continuous series of abdominal appendages is actually present in the embryo they are homologous with the thoracic legs. In my opinion there is no question that the latter is actually the case; for, in the first place, the accuracy of Kowalevsky's assertion is hardly open to doubt, since it is highly improbable that so cautious and delicate an investigator as Kowalevsky, whose observations have almost without exception been confirmed by all students, could go wrong in so simple a question; and, secondly, Tichomirow's statements also are very ample and definite. It is true that Graber says that his drawings are "indistinct;" but only the appendages of the eleventh abdominal segment are indistinct, or, strictly speaking, not shown at all, in Tichomirow's fig. 26, while the rest of the abdominal appendages are indeed faintly outlined but perfectly distinct. Particularly full and exact, however, is the description of the abdominal appendages given in the text (pp. 41-42). To this I can further add that, on the basis of my own investigations upon the germinal streak of *Gastropacha pini*, I can entirely confirm Tichomirow's account, since in this moth also at a very early stage in its development a continuous series of very small but yet distinct abdominal appendages is observable, and the figure given by Tichomirow for *Bombyx mori* (fig. 26) also applies in every detail to *Gastropacha pini*.

But if, with reference to the external development of the Lepidopterous embryo, we were absolutely unacquainted with anything but the published observations of Graber upon *Gastropacha quercifolia*, it would, I believe, nevertheless not follow therefrom that the pro-legs of caterpillars are "secondary" structures; for whereon should such a conclusion be founded—upon the late appearance of the abdominal appendages or upon the fact that the series thereof is not an unbroken one? But late appearance in itself cannot be

accepted as a proof of the secondary nature of an organ, since in the appearance of the organs in the embryonic development of closely allied animals no definite sequence whatever is observable; it is possible for one and the same organ or system of organs to appear in one animal very early but in another very late. Thus, for instance, in *Apis* the pores for the stigmata are almost the very earliest differentiations of the segmented germinal streak, while in *Blatta germanica* they are not observable until after the segmentation of the extremities has begun. But does it follow from this that the stigmata are primary in Hymenoptera but secondary in Orthoptera? With regard, however, to the discontinuity in the series of abdominal appendages and their appearance only on those segments on which pro-legs are present in the caterpillar, this fact, which has hitherto only been observed in the embryo of one moth, does not yet prove in itself that the pro-legs are secondary structures. Instead of setting up the hypothesis that the caterpillars had acquired their abdominal appendages in post-embryonic development, and that subsequently the first appearance of these organs was transferred to early (embryonic) stages, we are just as much justified in assuming that in the embryo, which originally possessed a continuous series of abdominal appendages, later on rudiments of only those appendages began to appear which also persisted in post-embryonic development; further, that the suppression of the rest of the abdominal extremities resulted from the same cause as that which in the embryo of other Insects is responsible for the non-appearance of the whole of the abdominal feet, *i. e.* in consequence of disuse. The second hypothesis is even *à priori* not less probable than the first; but, by the fact that in certain lepidopterous embryos a continuous series of abdominal legs is actually present, it is completely confirmed and is certainly the only correct one. When discussing my paper upon the external development of *Blatta germanica*, Prof. Emery, *inter alia*, writes as follows*:—"The abdominal legs of lepidopterous caterpillars may quite well have developed afresh through reversion in phylogeny from the embryonic rudiments which quickly disappear in the case of other insects, and those caterpillars may with much probability be derived from primitive *Campodea*-like forms. It is probable that cases of atavism of this kind play a much more important part in phylogeny than is generally supposed. Primitive structures are developed

* Emery, "Neuere Arbeiten über die Phylogenie der Insekten," Biol. Centralbl., Bd. ix., 1889-90, pp. 396-405.

afresh through new adaptation from a rudimentary or even latent condition, and thus new conditions of organization arise which, with equal justice, may be regarded as either primitive or secondary." I give this quotation here in order to point out that some years ago I already drew attention to the possible (and probable) great importance of atavism in ontogeny and phylogeny* by designating the cases of this class as "normal periodic atavism." While I thus agree with Herr Emery in considering it, as a matter of principle, a very probable possibility that organs which are secondary in ontogeny may be homologous with those which are primary in phylogeny, I nevertheless regard it as superfluous, and even impossible, to apply this view to caterpillars. That the polypod caterpillars cannot be derived from hexapod (*Campodea*-like) larvæ is proved at once by the fact that the latter may themselves be polypod in their embryonic development (e. g. *Hydrophilus*). The entire difference between hexapod and polypod Insect larvæ thus depends upon the circumstance that in the former the abdominal legs atrophy before the animal is hatched, while in the latter they persist in post-embryonic development. It is clear from the embryology of Insects that the polypod larvæ cannot be derived from the hexapod; on the other hand, however, palæontology teaches us that the oldest Insects possessed an incomplete metamorphosis, and therefore were hexapod after leaving the egg, and that consequently also the hexapod larvæ are not to be derived from polypod forms. Thus the only alternative is to suppose, what is also most natural, that the hexapod as well as the polypod larvæ in different orders of Insects have arisen independently of one another.

Having discussed the question of the abdominal extremities of caterpillars, I must also briefly allude to the abdominal appendages of the other Insect larvæ. As I have stated above, Dr. Haase has gathered together in his new paper† almost all the instances which belong to this category. Unfortunately he at the same time utilizes for his deductions almost exclusively zoographical and anatomical facts, while on the other hand he appears to regard the results of comparative embryology as superfluous. Thus, for instance, it is enough for him to establish the fact that the abdominal appendages do not lie directly in prolongation of the line of

* Cholodkowsky, "Sur la morphologie de l'appareil urinaire des Lépidoptères," *Archives de Biologie*, t. vi., 1885, pp. 497-514, pl. xvii.; "Sur les vaisseaux malpighiens des Lépidoptères," *Comptes Rendus Acad. Paris*, t. xcviii. pp. 631-633, t. xcix. pp. 816-819 (1884).

† *Op. cit.*

the thoracic legs, but somewhat to the side of or inwards from it, in order to reject the homology between these appendages and the thoracic legs. It appears to me, however, that the acceptance or rejection of homologies is, in the great majority of cases, absolutely impossible without reference to embryology, which alone can show us whether the appendages in question proceed or not from abdominal legs, of which rudiments are formed in the embryo. If it is precisely the embryological facts that are wanting the question must remain undecided, and all conclusions are premature. Thus, for example, many Tenthredinid larvæ possess numerous abdominal appendages which appear in the highest degree similar to those of lepidopterous caterpillars. But since the embryology of the saw-flies, apart from a few extremely incomplete statements by Packard *, is as yet unknown, the nature of the appendages in question, notwithstanding their great similarity to those of caterpillars, cannot be precisely determined.

Of great interest is the question as to the morphological value of the so-called gonapophyses, *i. e.* the male copulatory organs, ovipositors, the sting of the Hymenoptera, &c. Under the head of gonapophyses I also include, *inter alia*, the male *appendices copulatarii* of the Lepidoptera. Some authors, such as Huxley and Dewitz, consider the gonapophyses to be the homologues of legs; others, such as Claus, do not venture to express themselves positively upon this question, and merely remark that the homology of the gonapophyses with the legs is not proved; finally, certain authors decisively reject this homology. Against the homologization of the gonapophyses with legs various evidence can be adduced. Thus, for instance, in *Machilis* ventral styles are also found upon the abdominal segments which bear the gonapophyses, so that these segments are each provided with two pairs of appendages. We have already seen that the question of the value of the ventral styles of the Thysanura cannot be decided, on account of our ignorance of their embryological development. But apart from this, the fact of the presence of two pairs of appendages upon one segment is not in itself an argument against the homologization of these appendages with the legs. In the first place it has been shown by the beautiful investigations of Uljanin upon the post-embryonic development of the bee † that it is possible for appendages

* Packard, "Embryological Studies on Hexapodous Insects," *Memoirs of the Peabody Academy of Science*, v. 1, no. 3, 1872, 17 pp., 3 plates.

† B. Uljanin, "Zur postembryonalen Entwicklung der Biene," *Protokolle der Sitzungen der Moskauer Gesellschaft der Liebhaber von Naturwissenschaft, Anthropologie und Ethnographie*, Jahrg. ix., 1872, Moskau, pp. 17-32, Taf. ii.-v. (in Russian).

which are originally simple to subsequently split longitudinally, whereby two pairs of appendages are produced, which all taken together may be homologous with one pair of legs. In the second place, if the hypothesis that the ventral styles correspond to the coxal appendages is correct, the ventral styles of the eighth and ninth segments in *Machilis* may represent the coxal appendages detached from the trunk of the extremities. Other objections against the homologization of the gonapophyses with the legs are based upon the late appearance of the former, which are therefore supposed to be "secondary" structures. I have already had occasion to point out that more or less late appearance of the organs in development is of little importance for the setting up of homologies; I am convinced that even organs which first appear in post-embryonic life may be equivalent to those which are developed at a very early stage, since there really exists no radical difference between embryonic and post-embryonic development. If certain organs may be referred to purely post-embryonic adaptation, we are nevertheless not bound to consider as phylogenetically secondary all structures which are post-embryonic in appearance. In the particular case of those Insects in which the development of the gonapophyses has been sufficiently investigated (*e. g.* the bee) the homology of the latter with the legs appears to be precisely very probable. According to Uljanin*, in the bee the sting develops from two pairs of appendages at the posterior end of the abdomen, and the hindermost appendages very quickly split longitudinally. It is stated by Bütschli† that in the embryo of the bee the two posterior pairs of abdominal appendages are especially developed. Grassi‡, too, alludes to these appendages, although (contrary to Bütschli) he denies the presence of the rest of the abdominal extremities. It appears that these hindermost abdominal appendages subsequently greatly diminish in size, so that immediately before hatching takes place they are represented by flat ectodermal disks (Kowalevsky§). It is only after the second ecdysis of the larva (according to Uljanin) that they commence to grow bigger, and, what is especially interesting, they even exhibit an indistinct segmentation. The development of these abdominal appendages therefore retrogrades somewhat towards the end of embryonic life, and it is only in post-

* *Op. cit.*† *Op. cit.*

‡ B. Grassi, "Intorno allo sviluppo delle Api nell' uovo," Atti dell' Acad. Gioenia di Scienze Natural. in Catania, S. 3°, vol. xviii., 1884, 78 pp., 10 plates.

§ *Op. cit.*

embryonic development that further progress takes place. According to Haase these appendages cannot be homologous with the legs, because their earliest rudiments are purely ectodermal. "This view," he writes, "which appears to be supported by Grassi also, was expressed for the first time in 1872 by Uljanin, who demonstrated the development of the gonapophyses from subcutaneous imaginal disks." This reference to Uljanin, which, as I shall immediately show, is quite unjustifiable, is doubtless due to Dr. Haase's ignorance of the Russian tongue; for, contrary to what is stated by Dr. Haase, Uljanin expresses his deep conviction that the parts of the sting are homologous with the legs and that the lancets correspond to one, and the quadrate plates together with the sheath to another pair of legs. It is also proved by Uljanin that the thoracic legs likewise develop from subcutaneous imaginal disks, so that no difference really exists between the mode of development of the thoracic legs and that of the abdominal appendages. There is consequently no reason for not regarding the bee's sting as homologous with the thoracic legs.

The embryology of the bee also furnishes excellent evidence of the justice of the view which, as I have stated above, I expressed years ago*, that organs also which are really secondary in ontogeny may have just the same morphological and phylogenetic value as undoubtedly primary structures. The thoracic legs of the embryo of the bee are so strongly developed that they have been observed by every one of the embryologists who have investigated the development of the animal in question. These legs diminish in size as the development of the embryo proceeds, and become transformed into flat ectodermal disks (Kowalevsky). It is only in the course of larval and pupal life that they undergo further development and become definite legs. The thoracic legs of the bee are therefore secondary according to their mode of development; yet it will scarcely occur to any one to doubt their homology with the thoracic legs of other Insects. Just as "secondary" are also the thoracic legs of the bark-beetles (according to the investigations of Packard†, which I can confirm from my own studies), of the flea (according to Bal-

* Cholodkowsky, "Sur la morphologie de l'appareil urinaire des Lépidoptères," *Archives de Biologie*, t. vi., 1885, pp. 497-514, pl. xvii.; "Sur les vaisseaux malpighiens des Lépidoptères," *Comptes Rendus Acad. Paris*, t. xcvi., pp. 631-633, t. xcix. pp. 816-819 (1884).

† Packard, "The Development of the Bark-Beetles (*Xyleborus* and *Hylurgops*)," U. S. Department of Agriculture, 3rd Report of the Entomological Commission (Washington, 1883), pp. 280-282, pl. xxii.

biani *), and probably of a large number of Insects whose larvæ are apodous. The cephalic appendages (antennæ and maxillæ) of the Muscidæ are likewise subject to degeneration in the larval stage, and subsequently develop a second time. Among the internal organs all parts which in the pupal stage are destroyed by histolysis are also "secondary" in the adult. Similar processes may also be observed among the Crustacea. Thus in the Stomatopoda (in *Erichthus* according to Claus) three posterior pairs of thoracic legs do not appear until the end of the larval stage, while the third to the fifth pairs are developed very early, to subsequently atrophy and then reappear. With reference to this remarkable phenomenon Lang † writes as follows:—"The first start towards the formation of the whole or of the majority of the typical appendages of the Malacostraca, which we here describe and which is subsequently annulled, is without doubt to be ascribed to the power of heredity. The temporary disappearance of a portion of the extremities is most probably a case of adaptation to the special conditions of larval existence, which are so different from those of the adult animal. If, however, in the course of time the first fruitless and useless start became gradually weaker, and were finally entirely omitted, we should in the case of Loricata and Stomatopoda meet with phenomena entirely similar to those in the development of the Brachyura, where the formation of the last five thoracic segments and their appendages takes place so extraordinarily late." I would willingly subscribe to these words, and I consider that Lang's conclusions are also to be extended to other animals, such as, for example, the Insects. It is evident that that which is secondary in ontogeny is by no means always also phylogenetically secondary. Altogether it appears to me that the conception of what is secondary is only too often misused: should any phenomenon be inconvenient to an author for the working-out of his theories, he simply declares it to be "secondary," and thinks that in so doing he has disposed of the whole question.

The development of the male gonapophyses has unfortunately received much less investigation than that of the oviduct and of the sting. The very interesting "*forcipes*" of the humble-bees represent very well developed and even segmented appendages ‡, which quite convey the impression

* Balbiani, "Sur l'embryogénie de la puce," *Comptes Rendus Acad. Paris*, t. lxxxi., 1875, pp. 901-904.

† Lang, 'Lehrbuch der vergleichenden Anatomie,' Abth. 2 (Jena, 1889).

‡ Schmiedeknecht, "Monographie der in Thüringen vorkommenden

of somewhat modified legs. Packard's investigations*, however, appear not to confirm the homology of these appendages with the legs, since they are said to develop from three pairs of tubercles which all belong to the ninth segment. Kraepelin likewise rejects the homology of the copulatory organs of the drone (*Apis mellifica*) with the parts of the sting of the female. This question needs further investigation. Matters are somewhat better with regard to the male forcipes of the Lepidoptera. As is well known† these forcipes develop from the hindmost pair of pro-legs of the caterpillar (the so-called claspers); but according to Tichomirow the latter arise from the hindermost pair of the embryonic abdominal appendages, i. e. from the appendages of the eleventh segment, and therefore correspond to the cerci of other Insects. For Tichomirow states that the caudal lobes diminish more and more in the course of the development, and finally are almost entirely absorbed in the formation of the hindermost pair of the abdominal legs of the larva, whose ninth abdominal segment arises through the fusion of the sixteenth to the eighteenth embryonic segments. I have shown above that in all probability the cerci are homologous with the true legs; the forcipes of the male Lepidoptera are consequently likewise to be regarded as homologues of the legs. In the adult state they are attached to the ventral half of the ninth abdominal ring, which in many species is greatly modified, but in some preserves its typical annular shape.

The gonapophyses are thus, in certain cases at least, to be considered as homologues of the legs.

In considering the morphology of the germinal streak of Insects I cannot refrain from touching upon the question of the relation of the germinal streak and the embryonic envelopes to the Trochosphere-theory. We know that in 1878 B. Hatschek produced a scheme of the formation of the Annelidan body, according to which the foremost or cephalic segment is contrasted with the whole of the remaining body-segments, as forming the trunk. This scheme has recently also been applied to the germinal streak of Insects, which, according to Haase, is composed, (1) of the antennæ-bearing

Arten der Gattung *Bombus*," Jenaische Zeitschrift, 12 Bd., 1878, pp. 303-430, with two plates.

* Packard, "Observations on the Development and Position of the Hymenoptera," Ann. & Mag. Nat. Hist. xviii., 1866, pp. 82-99.

† Barthelemy, 'Recherches d'anatomie et physiologie générales sur la classe des Lépidoptères' (Toulouse, 1864), 11 planches; Künckel, "Signification morphologique des appendices servant à la suspension des chrysalides," Comptes Rendus Acad. Paris, t. xci., 1880, pp. 395-397.

"frontal piece" (the "cephalic segment" of Hatschek); (2) of a series of limb-bearing metameres, which are homologous with one another; and (3) of a cerci-bearing end-segment. I have already adduced evidence against the view that the antennæ and cerci are not homologous with the legs, and I consider it superfluous that I should here revert to the question. I will merely point out that although the antennæ are not pre-oral and belong to the primary trunk, nevertheless the pre-oral segment is actually present and is separated from the rest of the body by the antennary groove. Whether this pre-oral segment is comparable to the body of the Trochosphere or not is very questionable. On the one hand, this comparison is not to be rejected because the pre-oral segment contains no coelomic cavities, while on the other the Insects have certainly receded so far from their ancestors the Annelids that a repetition of the Trochosphere stage in their development may also be entirely omitted. The fact that the pre-oral ganglia develop from rudiments which are separated from the ventral chain is scarcely to be considered of such high importance as has been ascribed to it by certain investigators*, since, as we have already seen, each ganglion of the ventral chain may also arise from a separate rudiment. That the pre-oral segment contains no coelomic cavities is perhaps explained by the rudimentary character of its appendages (labrum), and it is at the same time also advisable to wait for detailed investigations upon the development of this segment, in which perhaps, as in the "end-segment" of *Blatta germanica*, rudimentary coelomic cavities will be discovered.

As regards the embryonic envelopes, the question as to their morphological value is answered in very different ways. P. Mayer† regards the formation of the embryonic envelopes as a summary ecdysis on the part of the embryo, a view which is also adopted by Balfour. Tichomirow‡ and Emery§ consider it possible to compare the embryonic envelopes of Insects with the carapace of Crustacea. Kennel||

* Schimkewitsch, "Étude sur le développement des Araignées," Arch. de Biologie, t. vi., 1885, pp. 515-584, pls. xviii.-xxiii. The same in Russian, St. Petersburg, 1888.

† P. Mayer, "Ueber Ontogenie und Phylogenie der Insekten," Jenaische Zeitschr. x., 1876.

‡ A. Tichomirow, 'Entwicklungsgeschichte des Seidenspinners im Ei' (Moskau, 1882: in Russian).

§ Emery, "Referat über die Arbeiten von Korotnew und Grassi," Biol. Centralbl., Bd. v., 1887, pp. 656-657.

|| Kennel, "Entwicklungsgeschichte von *Peripatus*," Arbeiten a. d. zool.-zoot. Inst. in Würzburg, Bd. 7, 1885, pp. 95-200, Taf. v.-xi., Bd. 8, 1888, pp. 1-93, Taf. i.-vi.

considers the same structures to be rudiments of the Trochosphere. Will* suggests a new hypothesis, which at first sight appears very simple and plausible; for, while comparing the internal germinal streak of Insects with the germinal streak of Myriapods (which, as is well known, increases very greatly in length, and finally bends together in the middle and becomes invaginated into the nutritive yolk), he considers the amnion of Insects to be homologous with the posterior half of the Myriapod germinal streak. The Insects with an internal germinal streak would consequently be phylogenetically older than those with an external one (contrary to the opinion of P. Mayer, according to whom the reverse is the case, and the Insects with an external germinal streak are the older). Of all these hypotheses that which is proposed by Tichomirow and Emery appears to me to be least happy. The entire results of embryology and comparative anatomy compel us to suppose that the Crustacea must have had an origin separate from that of the rest of the Arthropoda; so that a repetition of the Crustacean carapace in the development of Insects appears to be simply impossible. Will's hypothesis is hardly applicable to those Insects in which the cephalic fold (which, according to Will, is a secondary formation) of the amnion constitutes almost by itself the entire amnion (*Apis*), while the caudal fold is very little developed; it is also very improbable that the cephalic and caudal folds of the amnion, which are so similar in their formation, were of quite different origin. Until the appearance of Graber's paper† P. Mayer's hypothesis seemed to me to be the most probable; according to Graber, however, the amnion in *Melolontha* consists not merely of ectoderm but also of mesoderm, which is surely irreconcilable with the interpretation of the amnion as a cast-off skin. Kennel's view, on the contrary, appears to find confirmation in this remarkable fact. Altogether the above-mentioned hypothesis of Kennel seems to me to be the only one against which no evidence of importance can be adduced. I therefore gladly allow with Kennel that the embryonic envelopes are no new formation,

* L. Will, "Entwicklungsgeschichte der viviparen Aphiden," Zool. Jahrb., Abth. f. Morphol. Bd. iii., 1888, pp. 201-286, Taf. vi.-x. (Also Arb. zool.-zoot. Inst. Würzb., Bd. 6, 1888, "Ueber die Embryonalentwicklung d. viv. Aphiden," Sitz.-Ber. naturf. f. Ges. Rostock, 24 mai, 1887; Arch. Ver. Freund. Naturg. Mecklenb., 1887, 41 Jahrg. 1888; "Zur Entwicklungsgesch. d. vivip. Aphiden," Biol. Centralbl., viii., 1888, no. 5.)

† Graber, "Vergl. Studien über die Keimhüllen und die Rückenbildung der Insekten," 54 pp., 8 plates, 32 woodcuts, Denkschriften d. math.-naturw. Classe Kais. Akad. Wiss. Wien, 1888.

but, on the contrary, represent what is oldest in the Insect embryo. This view is also in accordance with the fact that it is precisely in those Insects (Diptera) which have undoubtedly departed furthest from the primitive forms that the embryonic envelopes are most feebly developed and are almost entirely wanting.

To sum up the whole of what has been stated above, I advance the following main theses:—

1. The head of Insects contains more than four protozonites, probably six, of which one is pre-oral, but the rest are post-oral.

2. The antennæ of Insects belong to the first post-oral segment and are entirely homologous with the remaining ventral extremities. They do not correspond to the antennæ of *Peripatus*, but probably to the chelicerae of Spiders, and perhaps to the second pair of antennæ of Crustacea.

3. Since the possibility that a number of segments in the germinal streak of different Arthropods have disappeared is not excluded, a homology of the mouth-parts of the different classes of Arthropoda cannot at present be set up.

4. The abdominal appendages of the Insectan germinal streak (including the cerci) are homologous with the thoracic legs. Herein it makes no difference whether these appendages are attached to the middle, at the side, at the front, or hind margin (are meso-, pleuro-, pro-, or opisthostatic, in the terminology of Graber), provided only that their cavity is immediately continuous with that of the somite to which they belong. The fact that the abdominal appendages usually remain unsegmented in nowise tends to show that they are not of the nature of limbs, since, for instance, the mandibles also are always unsegmented*.

5. Many of the abdominal appendages of larvæ and perfect Insects are homologous with the thoracic legs, even when they are secondary in ontogeny.

6. The primitive function of the first pair of the abdominal appendages was ambulatory, as also that of the remaining appendages. The ancestors of the Insects were therefore undoubtedly homopod, not heteropod.

7. The many-legged Insect larvæ are to be derived from the six-legged just as little as are, conversely, the hexapod larvæ from the polypod; both forms developed independently of one another.

* Whether the segmented branchial filaments of *Sisyra* and *Sialis* belong to this category is doubtful, but can only be decided by embryological investigations.

8. The embryonic envelopes of the Insects probably correspond to the remains of a Trochosphere.

The above theses convey the leading features of my view as to the phylogenetic relations of Insects. Widely different decisions as to the origin of Insects have been pronounced by authors. The hypotheses dealing with the question are enumerated and criticized at some length in Graber's work 'Die Insekten' * (pp. 66-71) and in Sograf's memoir on the development of *Geophilus* †, so that I can dispense with a comparison of them. I will merely remark that I entirely agree with Graber's opinion upon the *Zoœa*-hypothesis—"a more unsuitable claimant to be regarded as the ancestor of terrestrial Insects ('einen unpassenderen Landkerfcandidaten') could never have been found,"—as well as with Sograf's argument against the Myriapod hypothesis of Haeckel ‡. Quite recently the relationship between Insects and Myriapods has been placed more and more beyond doubt, thanks to the work of Moseley §, Balfour ||, Kennel ¶, Sedgwick **, and Gaffron †† upon the anatomy and embryology of *Peripatus*, as also to the investigations of Ryder ‡‡,

* München, 1877.

† Sograf, "Zur Kenntniss der Embrionalentwicklung von *Geophilus*," Nachr. der Moskauer Gesellschaft der Freunde der Naturwissenschaft &c., Bd. 43, Lief 1, 1883 (in Russian).

‡ Sograf writes:—"The pulli of the Chilognatha correspond to the germinal streak of Insects, provided with six (anterior) pairs of extremities. . . . Consequently in order that it should be possible to compare the Chilognatha with Insects or Arachnids, it would have to be proved that the hexapodous Chilognathan embryo formerly possessed a far greater number of extremities, all of which atrophied except the three anterior pairs. That such a metamorphosis formerly belonged to the Chilognatha, but was afterwards lost, is very improbable." As we see, the question here also depends upon whether the embryo acquires or loses its legs before or after leaving the egg.

§ Moseley, "On the Structure and Development of *Peripatus capensis*," Phil. Trans. Roy. Soc. London, vol. clxiv. 1874, pp. 757-782, 4 plates.

|| Balfour, "The Anatomy and Development of *Peripatus capensis*," Quart. Journ. Micr. Sci. vol. xxiii., 1883, 8 plates.

¶ Kennel, "Entwicklungsgeschichte von *Peripatus*," Arbeiten aus dem zool.-zoot. Inst. in Würzburg, Bd. 7, 1885, pp. 95-200, Taf. v.-xi., Bd. 8, 1888, pp. 1-93, Taf. i.-vi.

** Sedgwick, "The Development of *Peripatus capensis*," Quart. Journ. Micr. Sci. vol. xxv. 1885, pp. 149-168, 2 plates, vol. xxvi. pp. 175-211, 3 plates, vol. xxvii. pp. 467-550, 4 plates; "On the Fertilized Ovum of and the Formation of the Layers in *Peripatus*," Proc. Roy. Soc. Lond., vol. xxxix., 1885, pp. 239-244.

†† Gaffron, "Beiträge zur Anatomie und Histologie von *Peripatus*," Zool. Beitr. Schneid. 1 Bd., 1883-1885, pp. 33-60 and 145-165, 9 plates.

‡‡ Ryder, "The Structure, Affinities, and Species of *Scolopendrella*," Proc. Ac. Nat. Sci. Philadelphia, 1881, pp. 79-86.

Haase, Nassonow*, Grassi†, Oudemans‡, and others upon the morphology of the lower Insects and Myriapods. The fact, which was brought forward by myself for *Blatta germanica* and confirmed by Graber, of the remarkable division of the cavity of each somite into three sections, one of which is, in my opinion, homologous with the segmental funnel of *Peripatus*, seems to decide the question still more definitely in favour of the derivation of the Insects from homo- and poly-pod and, probably, *Scolopendrella*-like ancestors. Even Graber, who, as I think, ascribes too great importance to the saccate shape of the first abdominal appendages, nevertheless considers it probable that the ancestors of the Insects were Myriapod-like, and admits that this supposition appears *à priori* to have most to be said in its favour. If, however, we weigh the great differences between the Crustacea on the one hand and the rest of the Arthropoda on the other, a close relationship between Insects and Crustaceans appears simply impossible. The *Nauplius*-form of larva, an exclusively Crustacean possession, the remarkable resemblance in embryonic development between Insects and *Peripatus*, and the constitution of the respiratory and excretory organs, are facts which all compel us to conclude that the Arthropod type is at least diphyletic in origin. The Crustacea, indeed, are to be derived from marine Annelids, which in the course of their development passed through the Trochosphere stage (which in the Crustacean development became transformed into that of the *Nauplius*), while for the ancestors of the Tracheata we must look to terrestrial or freshwater Annelids, more of the Oligochaete type. The subtype Tracheata is at present rejected by several zoologists, since the Arachnids are separated from the rest of the air-breathing Arthropods and approximated to the Pœcilopods. I have above already adduced the evidence against the establishment of the groups Acerata (Kingsley) and Antennata (Lang), and here need only add that the mode of development of the respiratory organs of the Arachnids (Schimkewitsch §, Morin ||) tells, in

* Nassonow, "Zur Morphologie der niederen Insekten," *Nachr. der Moskauer Ges. der Freunde der Naturwissenschaft &c.*, Bd. 52, Lief. 1, 1887 (in Russian).

† Grassi, "I progenitori dei Miriapodi e degli Insetti," *Atti Accad. Gioenia Sc. N. Catania*, (3) vol. xix., 1886, 83 pp. 5 plates; *Bull. Soc. Ent. Ital.* 1886, pp. 173-180, tt. 7, 8; *Atti Accad. Lincei*, (4) vol. iv., 1888, pp. 543-606, 5 plates.

‡ Oudemans, 'Beiträge zur Kenntniss der *Thysanura* und *Collembola*,' Berlin, 1889.

§ Schimkewitsch, "Étude sur le développement des araignées," *Arch. de Biologie*, t. vi., 1885, pp. 515-584, pls. xviii.-xxiii.

|| Morin, "Zur Entwicklungsgeschichte der Spinnen," *Biol. Centralbl.* vi. Bd., 1887, pp. 658-668.

my opinion, decidedly against the union of the Arachnids and Pœcilopods. It is indisputable that *Limulus* has very little in common with the Crustacea (the Trilobites and Merostomata excluded), and that the origin of the Arachnida is enshrouded in thick darkness; but the facts at our disposal appear rather to warn us against the dissolution of the sub-type Tracheata and the union of creatures so heterogeneous as the marine Pœcilopoda and the terrestrial air-breathing Arachnida.

LVI.—*Preliminary Descriptions of new Species of Madrepora in the Collection of the British Museum.*—Part II. By
GEORGE BROOK, F.L.S.

WHEN just a year ago I published in this Journal preliminary descriptions of a number of new species of *Madrepora*, I anticipated that by the present time a revision of the whole genus would have been ready for press. Considerable delay has been caused by the acquisition of further collections, particularly of the fine series of specimens from the Great Barrier Reef area collected by Mr. Saville-Kent, and of a further selection of specimens from the Macclesfield Bank, collected by Mr. Bassett-Smith, Surgeon R.N. Before these were received a number of the species now described were diagnosed from specimens in the general collection, the distribution of which is increased by their occurrence in the newly-acquired material. As the work of revision is not yet complete, I take the present opportunity of giving short descriptions of forty new species. I believe that the characters indicated will be found sufficient to distinguish the species, although in some cases this may not at present appear to be the case, owing to the lack of precision in many of the descriptions of older species. This I hope to rectify as far as possible in the revision of the genus, the publication of which will not, I trust, be further delayed.

Madrepora ambigua.

Corallum subhorizontal (? suberect), somewhat flabellate; branches irregularly confluent, basal parts fused into a solid mass. Branches 1·5 centim. diameter, with a few short arched and blunt divisions on the upper surface. Apical corallites scarcely prominent, 2·5 to 3, rarely 3·5 millim. diameter. Lateral corallites irregular and very unequal, many immersed; prominent ones chiefly spout-shaped, spreading;

outer part of wall thin when short, but thick and keeled in the stouter corallites; length 0·5 to 2·5 millim., diameter 1 to 2 millim. Star distinct. Branches on the under surface not flattened, without branchlets; corallites numerous, all immersed.

Northumberland Island (*Saville-Kent*).

Madrepora arcuata.

Corallium pedicellate, flabellate or subvasiform, with numerous slender spiciform branchlets on the upper surface; total thickness not over 2 centim. The under surface is composed of a close reticulum of slender branches with elongate and narrow spaces between; corallites chiefly appressed, tubular, or immersed. Branchlets on the upper surface arcuate, often proliferous, 1·2 centim. long and 4 millim. thick. Apical corallites cylindrical, 1·5 millim. diameter. Lateral corallites tubolabellate at an angle of 45°, 2·5 millim. long, 1 millim. diameter. Star very imperfect.

Samoa.

Madrepora armata.

Madrepora spicifera, Dana, Zoophytes, p. 443 (part.), pl. xxxiii. figs. 4 and 4a only.

Corallum umbellate rather than vasiform, flat above, under surface obliquely pedicellate. Differs from young *M. cytherea*, to which Dana thought his specimen might belong, in the scarcity of proliferous corallites on the spiciform branchlets on the upper surface, and in the occurrence of numerous very spreading and rather long tubular corallites on the under surface. Star scarcely developed.

Singapore; Diego Garcia; Fiji (*Dana*); ? Tahiti ('*Challenger*').

Madrepora assimilis.

Madrepora appressa, Quelch & ? Dana (non Ehrenberg).

Corallum corymbose, not pedicellate; branches horizontal, coalescing into a plate, with numerous irregular corallites on the under surface having a pore-like aperture; they are 5 millim. long and 1·5 millim. broad, usually applied to the surface throughout the whole length. Branchlets on the upper surface 6 to 7 centim. long and 6 to 8 millim. thick. Apical corallites 2 millim. diameter. Lateral corallites crowded, ascending, subequal, beaked nariform or compressed tubular with an oblique aperture; length 4 millim., diameter 1·2 and 1·4 millim. to 1·8 millim. Star well developed.

Amboina ('Challenger'); Seychelles, 12 fathoms (*H.M.S. 'Alert'*).

Madrepora australis.

Corallum small, cespitose, base very broad. Branches divided near the base into two or three erect digitiform branchlets 3·5 to 4·5 centim. long and 2 to 2·5 centim. diameter at the base, slowly tapering to a blunt apex. Apical corallites somewhat hemispherical, 3 to 4 millim. diameter. Lateral corallites rather distant, short, spreading, tubular, with more or less oblique apex; diameter 1 to 2·5 millim., the more prominent ones about 2 millim., length 1 to 2 millim.; wall firm but not thick, the inner part rarely wanting.

Darnley Island and Wreck Bay (*Jukes*); Gt. Barrier Reef (*Saville-Kent*).

Madrepora bæodactyla.

Madrepora seriata, Brüggemann (non Ehrenberg), Phil. Trans. vol. clxviii. 1878, p. 575.

Corallum low, cespitose from a broad incrusting base. Branches erect digitiform, simple or subdivided, apex blunt or conical; length 3 to 4 centim., diameter 7 to 10 millim. Apical corallites 2 to 3·5 millim. diameter, margin rounded. Lateral corallites chiefly open nariform or gutter-shaped, lower border almost horizontal; length 1·3 to 2 millim., rarely more, diameter 1·6 millim. Wall usually thin; margin not rounded, but a little thickened in one specimen. Star indistinct.

Rodriguez.

Madrepora bifaria.

Corallum horizontal, with numerous erect spiciform branchlets on both the upper and under surfaces; colony 12 centim. thick. Branchlets simple, bi- or trifid, rising obliquely, but arched near the base, 3 to 4·5 centim. long and 7 or 8 millim. diameter near the base, slowly tapering. Apical corallites 2 millim. diameter, cylindrical. Lateral corallites half-tubular, labellate, or tubular with an oblique apex, at an angle of about 45°; length 2 to 3·5 millim., diameter about 2 millim., but shorter below and with a round aperture. The branchlets on the under surface are practically identical with those above. Star well developed.

Java.

Madrepora botryodes.

Madrepora gonagra, Brüggemann, Abhand. nat. Ver. Bremen, 1877, p. 398.

Madrepora Haimeii, Brüggemann, loc. cit. p. 575 (part.).

Corallum subcespitose, sometimes incrusting a dead colony; new growth about 3·5 centim. high. Branches erect and crowded, 1·2 to 1·5 centim. diameter, but broader at the apex, which is occupied by numerous crowded proliferous corallites, which form an acervate apex; in old specimens the apices become fused together. Apical and proliferous corallites 3·5 to 5 millim. diameter, cylindrical, but with crowded margin and small aperture. Lateral corallites appressed, tubular or half-tubular, very variable in size, wall often dilated; the more prominent ones are 2 to 3 millim. diameter, with rounded margin, many others verruciform. Star very well developed.

Rodriguez.

Madrepora brevicollis.

Corallum cespito-arborescent; branches 8 to 12 centim. long and 1·5 centim. thick in bushy specimens, but may be 22 centim. or more in those which extend obliquely; the former are much divided, and bear numerous spreading twigs and short proliferations. Apical corallites 3 to 4 millim. diameter, shortly cylindrical, margin often a little rounded. Lateral corallites much crowded, chiefly half-tubular and labellate, sometimes distinctly compressed; diameter 1·5 millim., more rarely 2 millim., outer part of the wall distinctly thickened in the stouter corallites. Star distinct. A variety with more or less tubular corallites occurs amongst the Rodriguez specimens, and was referred by Brüggemann to *M. pustulosa*, Ed. & H. The same variety also occurs in Mr. Saville-Kent's collection from the Great Barrier Reef.

Rodriguez; Great Barrier Reef, Torres Straits (*Saville-Kent*).

Madrepora bullata.

Corallum cespitose from an incrusting base; branches simple or forked, 5 to 6 centim. long and 1·7 centim. diameter at the base, gradually tapering to a blunt apex, covered with scattered and spreading proliferous corallites. Apical corallites 5 to 6 centim. diameter, margin strongly curved except in young condition. Lateral corallites tubular, with somewhat oblique apex, rarely nariform, increasing in length from the apex downwards for a distance of 3 centim., below

which a few are more elongate, but the majority short. Star very prominent. Differs from *M. canaliculata*, Klz., in the complete absence of dimidiate corallites and in the much better developed star.

Port Denison (*Saville-Kent*).

Madrepora calamaria.

Madrepora plantaginea, Brüggemann (non Lamarck), Phil. Trans. vol. clxviii. p. 575.

Madrepora acervata, Brüggemann (non Dana), ibid. p. 575.

Corallum cespitose from a short pedicellate base; marginal branches short and horizontal; middle branches 7 centim. long and 1.5 centim. thick, crowded and angular, more or less divided; divisions digitiform, little spreading. Apical corallites somewhat conical, 3.5 to 5 millim. diameter at the base. Lateral corallites very unequal in size, many appressed and dilated, more or less completely tubiform; length 3 to 5 millim., diameter 2 to 2.7 millim., but with small or sub-immersed ones between. Star indistinct.

Rodriguez.

Madrepora clavigera.

Corallum forming horizontal fronds 3 centim. thick, the main divisions reticulately coalescent; branches sinuous, flattened below, 1 centim. broad. Corallites on the under surface chiefly marginal, stout, spreading, tubular with rounded apex, some are 8 millim. long and bear buds. Upper surface of main divisions with numerous hemicotyloid and appressed tubular corallites. Branchlets on the upper surface erect, 2 centim. long, and rarely over 4 millim. diameter at the base if simple; each consists typically of an elongate club-shaped apical corallite, which bears buds which near the base are hemicotyloid and irregular, but tubular above, where from one to four radiating corallites surround the apical one. Apical corallites 7 to 12 millim. long, with a maximum diameter of 4 to 4.5 millim.

The type specimens were presented by Captain Belcher, R.N., but the habitat is not recorded.

Madrepora cophodactyla.

Corallum broad, flattened, cespitose, with a very broad base. Branches short, stout, and very obtuse at the apex, simple or divided near the middle; length 3 to 5 centim., diameter 1.7 to 2 centim. at the base and over 1 centim. at the apex. Apical corallites 3 to 3.75 millim., scarcely prominent. Lateral corallites stout, dilated, appressed tubular, with the

inner part of the wall short and the margin much rounded ; aperture elliptical ; diameter 2·2 to 3 millim., length 2 to 3 millim.

The species is quite distinct from any which have come under my notice, but unfortunately the habitat is not recorded.

Madrepora coronata.

Corallum cespitose, or in large specimens forming broad, much flattened clumps from an incrusting base. Branches short, crowded, acervate, undivided except near the margin, often broadest at the apex ; length 1·2 to 3 centim., diameter 5 to 7 millim. at the base, but often 1 centim. at the apex. Apical corallites cylindrical, 2 to 3 millim. diameter and 4 millim. exsert, usually two or more corallites surrounding the axial one are of the same dimensions. Lateral corallites large, appressed, but with wide aperture ; form variable, nariform at first, but dimidiate tubular or funnel-shaped later in growth ; length 2 to 4 millim., diameter 1·5 to 2·5 millim., crowded near the apex, distant and less prominent below.

Great Barrier Reef (*Saville-Kent*).

Madrepora decipiens.

Corallum consisting of stout subprostrate branches with erect digitiform branchlets or more slender and irregularly fastigiate. Apical corallites cylindrical, 2·5 to 3 millim. diameter, not over 2 millim. exsert. Lateral corallites crowded, of two kinds—the one stout and prominent, sometimes bearing buds, the other small, labellate, subimmersed or immersed ; the prominent ones are cylindrical, with a more or less deep notch in the inner part of the wall, elongate and appressed near the apex, spreading and shorter below ; length 2·5 to 6 millim., diameter 2 to 2·2 millim.

Great Barrier Reef (*Saville-Kent*).

Madrepora Elseyi.

Corallum cespito-arborescent ; branches sometimes relatively long, with a cluster of branchlets near the apex, at other times resembling *M. brevicollis* in habit. Branches 1 to 1·5 centim. diameter ; branchlets numerous and acuminate. Apical corallites 2 to 3 millim. diameter. Lateral corallites ascending, tubular ; wall thick ; margin much rounded ; inner part of the wall often shorter ; average length 2·5 millim., diameter 1·5 to 2 millim., becoming verruciform below ; many proliferous corallites occur at intervals.

North Australia (*Elsey*), types; Great Barrier Reef area (*Saville-Kent*).

Madrepora exilis.

Corallum very variable in form, shrubby arborescent to virgate, with short peripheral twigs as in *M. ornata*. Apical corallites scarcely 2 millim. diameter, cylindrical. Lateral corallites nariform or tubo-nariform, a little spreading, becoming tubular and proliferous; usually 2 millim. long and 1.5 millim. diameter; wall firm and a little thickened. Numerous subimmersed corallites between the branchlets have a ring-shaped border. Star distinct.

Arafura Sea, 10 fathoms (*H.M.S. 'Penguin'*); Port Denison (*Saville-Kent*); Macclesfield Bank, 13 fathoms (*H.M.S. 'Penguin'*).

Madrepora fruticosa.

Corallum bushy, cespitose, hemispherical above; middle branches 9.5 centim. long and 2 centim. thick, angular below. Apical corallites subhemispherical, 4 to 5 millim. diameter. Lateral corallites rather regular and spreading, a little compressed, chiefly tubiform, with the inner part of the wall always thin and usually shorter, the outer thick; length 3.5 to 5 millim., diameter 2.2 to 2.5 millim., shorter and quoit-shaped below; margin plain; star distinct.

Habitat not recorded.

Madrepora gemmifera.

Madrepora seriata, Quelch (part.), Challenger Reef Corals, p. 155.

Corallum massive, corymbose. Central branches erect, digitiform, 4 to 6 centim. long and 1.5 to 2.5 centim. thick, quadrate and proliferous near the base; marginal branches divided, the outer divisions covered with numerous spreading blunt twigs. Apical corallites hemispherical, 4 millim. diameter. Lateral corallites broad, spreading, subtubular or gutter-shaped, with small immersed cells between. Prominent ones increase in length from the apex downwards, often arranged in rows, the lower ones of a row being proliferous; length 1.5 to 4 millim., diameter 2 to 3.5 millim. Star indistinct.

Great Barrier Reef (*Saville-Kent*), Fiji (*'Challenger'*).

Madrepora grandis.

Corallum stout and lax arborescent, distal divisions relatively slender and tapering. Apical corallites 3 millim. dia-

meter, cylindrical. Lateral corallites on the distal 5 centim. of a branch, thin, ascending, tubular; cup deep; septa scarcely recognizable; length 4 to 5.5 millim., diameter 2 millim., with smaller and subimmersed corallites between. Below the distal 5 centim. all the corallites extend at right angles, and none are over 2 millim. long, and differ from those of *M. robusta* in similar situations in the thinner wall, the absence of dimidiate corallites, and the lack of a recognizable star.

Great Barrier Reef (*Saville-Kent*).

Madrepora Guppyi.

Corallum broad, flattened, cespitose from a broad base. Central branches simple or subsimple, conical, erect, 2 to 2.5 centim. thick at the base, 4 to 6.5 centim. long, regularly tapering and rather distant, apices often 4 centim. apart. Axial corallites 3.5 to 5 millim. diameter. Lateral corallites small, very crowded and spreading, subequal, usually thin-walled, often a little compressed, half-tubular or gutter-shaped, with a rounded apex; length 1.5 to 2 millim., diameter 1.2 to 1.5 millim. Star not well developed.

Solomon Islands (*Dr. Guppy*).

Madrepora irregularis.

Madrepora alces, Brüggemann (non Dana), Phil. Trans. vol. clxviii. p. 576.

Corallum consisting of alciform plates with marginal erect digitiform acuminate branches or of short plate-like clusters of incipient branchlets from a narrow base. Proliferous clusters very variable in diameter, up to 2 centim., but not over 1.5 centim. long, unless forming branches. Apical corallites cylindrical, 2 millim. diameter. Lateral corallites dimidiate or labellate; wall thin but firm, very unequal in length, the more prominent are about 1.3 millim. diameter and proliferous.

Rodriguez (types); Macclesfield Bank, 7 to 8 fathoms (*H.M.S. 'Penguin'*).

Madrepora Kenti.

Corallum horizontal or corymbose, with important branchlets on the under surface as in *M. bifaria*, but they are here not quite so stout as those on the upper aspect and the corallites are less prominent. Upper series of branchlets 3.5 to 6 centim. long and 7 to 10 millim. diameter. Apical corallites 2.5 to 3 millim. diameter, cylindrical. Lateral corallites

appressed tubular, with a ligulate border; length 3 to 4 millim., diameter 2·5 millim. across the lip, rather less at the base. Star moderate.

Thursday Island and Great Barrier Reef (*Saville-Kent*).

Madrepora latistella.

Corallum subhorizontal, without fusions, recalling the habit of *M. patula*. Branchlets on the upper surface erect, spiciform, simple or in groups; length 2·5 to 3 centim., diameter 5 millim. Apical corallites 2·5 to 3 millim. diameter, cylindrical. Lateral corallites chiefly gutter-shaped or labellate, ascending, becoming reduced to a crecentic rim near the base of the twigs; length 1·5 to 2 millim., diameter 1·3 millim. Star very well developed.

Port Denison (*Saville-Kent*).

Madrepora loripes.

Corallum bushy, with numerous short, stout, arched branchlets, usually without corallites on the inner side. Apical corallites 4 millim. diameter, margin rounded. Lateral corallites on the stouter divisions appressed tubonariform to spreading tubular and proliferous, becoming verruciform below: those near the apex are appressed, 4 millim. long and 1·5 to 2 millim. thick; others become thicker, more spreading, 5 millim. long and 3 millim. diameter, with shorter between; the stouter spreading ones gradually give rise to arcuate branchlets naked on the inner side. Star indistinct.

Great Barrier Reef (*Saville-Kent*).

Madrepora nigra.

Madrepora Ehrenbergi, B.-Smith (non M.-Ed. & H.), Ann. Mag. N. H. vol. vi. 1890, p. 452.

Corallum prostrate, openly reticulate, under surface sub-complanate. Upper surface provided with erect or ascending branchlets arranged irregularly, not over 7 centim. long, and about 1·2 centim. thick near the base, tapering to a slender apex. Apical corallites cylindrical, 2 millim. diameter, 1 to 2 millim. exsert. Lateral corallites on the branchlets tubular, with oblique or gutter-shaped apex, slightly compressed, length 2 to 4 millim., diameter 1·5 to 2 millim., margin always sharply defined; a few subimmersed ones are scattered between. On the main divisions the corallites are of the same type, but not compressed, and the aperture is not so oblique, about 2 millim. long and broad. Star very pro-

minent, and the septa are level with the margin for their whole length.

Tizard Bank, 5 fathoms (*H.M.S. 'Rambler'*).

Madrepora oligocyathus.

Corallum fan-shaped, semi-vasiform, pedicellate, closely resembling *M. microclados*, Ehrb., in habit. Apical corallites 2 millim. diameter, wall very thin. Lateral corallites immersed or subimmersed, excepting near the apex of the branchlets, where a few are short, round, nariform; the marginal branchlets usually bear more or less prominent corallites to the base, 1 millim. diameter, the outer part of the wall rarely over 1.5 millim. long. Star indistinct. Corallum very fragile.

Mauritius (*Robillard*).

Madrepora orbicularis.

Corallum disk-shaped, composed of several layers of radiating branches fused into a solid mass excepting near the periphery. Apical corallites 2.5 to 4 millim. diameter, cylindrical. Lateral corallites dimidiate and somewhat appressed near the apex of a branch, but spreading at right angles, 2.5 to 6 millim. long and 1.5 to 2 millim. thick; the larger ones are proliferous, but the buds are always small and delicate labellate; small labellate and immersed corallites extend between the more prominent ones.

Ceylon (*Dr. Ondaatje*).

Madrepora patula.

Corallum broad, depressed, bushy, from a short simple stem, diameter nearly three times the height. Branchlets on the upper surface spiciform, simple or in subparallel divisions, 2 to 4.5 centim. long, 7 millim. thick if simple, gradually tapering. Apical corallites 2 millim. diameter, cylindrical. Lateral corallites chiefly nariform, outer borders at an angle of 45°, more or less prominent quite to the base of the branchlets, length 2 millim., rarely 3 millim. with an elongate lip, diameter 1.2 to 1.5 millim, wall thin and fragile. Star indistinct. Branchlets on under surface 8 to 16 millim. long, 4 millim. diameter, tapering, with nariform, or more frequently verruciform, corallites.

Port Denison (*Saville-Kent*).

Madrepora pectinata.

Corallum plate-like or vasiform, recalling the habit of

M. conferta, Quel., and *M. hyacinthus*, Dana; total thickness 2.5 centim. Under surface flattened, openly reticulate, without projecting branchlets; corallites very short, open bursiform or immersed; diameter nearly 2 millim., wall rarely 1.5 millim. long. Branchlets on the upper surface arranged usually in groups of two to five along the course of each branch, 9 to 14 millim. long and 4 millim. thick. Apical corallites cylindrical, 1.5 millim. diameter. Lateral corallites short, spreading, round labellate, with curved lip; length 1.5, rarely 2 millim., diameter 1.2 to 1.5 millim. Star not recognizable.

Thursday Island (*Saville-Kent*).

Madrepora Rayneri.

Corallum horizontal, forming fronds similar to those of *M. speciosa*, Quel., but less confluent and dense. Branches scarcely flattened, naked below, except for a few scattered and appressed twigs, 1 centim. or more long. The upper surface of the branches bear scattered, appressed, nariform corallites and a few which are immersed. Branchlets erect, varying in importance from elongate simple corallites to stout divided twigs, each bearing several elongate radiating corallites at the apex. Elongate tubular corallites 1 to 1.6 centim. or more in length, 2.5 millim. diameter at the base, and 2 millim. at the apex, margin suddenly contracted. Star well developed.

Fiji (*F. M. Rayner*).

Madrepora recumbens.

Corallum subcespitose at first, becoming flattened, frondose, or semivasiform with increase in size. Proximal portions of main divisions fused into a solid plate in the larger specimens, without branchlets below. Branchlets on the upper surface short, subconical, and somewhat arcuate, 1 to 2.5 centim. long, and 8 to 13 millim. diameter, rapidly tapering, usually simple. Apical corallites 2 millim., rarely 2.5 millim., in diameter, cylindrical. Lateral corallites nariform to tubo-nariform or tubo-labellate, with smaller and immersed ones between; prominent corallites often in rows; length 1 to 2 millim., diameter 1.5 to 2 millim.; wall firm, but not thick. Star indistinct.

Great Barrier Reef (*Saville-Kent*).

Madrepora reticulata.

Corallum complanate or reticulate; branches elongate, but

rarely over 7 millim. thick. Under surface with distant spreading tubiform or tubo-nariform corallites, 1.5 millim. diameter, with immersed ones between; sometimes, apparently owing to secondary deposition of lime, the corallites on the under surface are obliterated. Upper surface covered with suberect labellate corallites, chiefly acuminate, length 1 to 3 millim., diameter 1.3 millim., certain of these become tubular and proliferous, and give rise to irregular groups of suberect twigs about 7 millim. long. Axial and proliferous corallites cylindrical, 2 millim. diameter. Star indistinct.

Amarante Islands (*H.M.S. 'Alert'*), Arafura Sea (*H.M.S. 'Penguin'*), ? Macclesfield Bank (*H.M.S. 'Penguin'*).

Madrepora sarmentosa.

Corallum flattened, bushy, extending obliquely, with short blunt crowded branchlets on both upper and lower surfaces. Branches 2 to 3 centim. thick, more or less fused into a solid plate below. Whole upper surface studded with blunt branchlets, simple or in groups of three or four, diameter 5 to 10 millim., length 1 to 2 centim., the more slender ones near the base. On the under surface the branchlets are similar to those above, but distinctly tapering, and scarcely so stout. Axial corallites 3.5 to 4.5 millim. diameter, sub-hemispherical. Lateral corallites on the basal parts subimmersed and dilated, on the distal divisions hemicotyloid, broad nariform or sub-labellate, length 2 to 3.5 millim., diameter 2 to 3 millim., outer part of the wall thick and convex. The interval between the branchlets is occupied by large immersed corallites. Star rarely well developed. Young specimens have the wall less thickened.

Great Barrier Reef (*Saville-Kent*).

Madrepora spectabilis.

Corallum stout, corymbose; outer branches oblique and proliferous, fusions rare. Central branches 6 centim. long, erect, 2 centim. diameter at the base and 1.5 centim. at a point only 1 centim. below the apex, usually crowded and angular, greatest diameter (including corallites) occurs about the middle of a branch and is often 2.5 centim. Axial corallites 6 to 7 millim. diameter, hemispherical, aperture only 1.5 millim. Lateral corallites variable in different situations. On marginal branchlets nearly all are tubular, with the inner part of the wall more or less incomplete, angle 45°, length 2 to 2.5 millim., diameter 1.5 millim. or a little over. Wall a little thickened, margin not rounded. On the

central branches the corallites are more unequal, tubular, dimidiate, or spout-shaped, with smaller thin-walled ones between, the majority becoming dilated, nariform, bursiform, or subimmersed lower down, many 2.5 millim. thick; between these numerous stout tubular corallites, 2.5 millim. long and broad, occur at irregular intervals, which indicate new outgrowths. Star moderate.

Habitat not recorded.

Madrepora squamosa.

? *Madrepora millepora*, Dana (non Ehrenberg), Zoophytes, p. 446, pl. xxxiii. fig. 2.

Corallum corymbose or subvasiform, flattened above, branches rarely coalescent. Main branches oblique, not flattened on under surface, but bearing numerous horizontal twigs 1.5 to 3 centim. long and 6 millim. diameter, provided with subimmersed corallites. Branchlets on the upper surface simple or subsimple and erect near the centre of the colony, more divided near the periphery; length of central ones 4.5 centim., diameter 8 millim. at the base, 4 millim. at the apex. Apical corallites 2.5 to 3.5 millim. diameter, cylindrical. Lateral corallites of the central branches small, equal, labellate with rounded lip spreading almost at right angles, rarely over 1 millim. diameter and 0.75 millim. long, but becoming wider and subimmersed towards the base. On the marginal branches the corallites are much larger and more distant; usually 2 millim. diameter, 2 millim. long, and the lips nearly 2 millim. apart; scarcely so spreading near the apex. Star moderately distinct in the corallites of the outer branches, but the septa are almost undistinguishable in the corallites of the central branches.

Great Barrier Reef (*Saville-Kent*).

Madrepora syringodes.

M. cf. Durrillei, Ortmann, Zool. Jahrb. Bd. iii. p. 151.

Corallum bushy or of the bottle-brush type. Branchlets 1.6 to 3.5 centim. long and 8 millim. thick, bearing several spreading proliferous corallites 1 centim. long, the stouter corallites of which also bear buds. Apical and proliferous corallites 3 millim. diameter, not over 2 millim. exsert, scarcely tapering, margin only slightly rounded. Lateral corallites at an angle of 45° ; either tubular, 1.75 millim. diameter and 3 to 4 millim. long, or shorter and then nariform. Septa scarcely recognizable in the lateral corallites, but well developed in the apical and proliferous ones.

Great Barrier Reef (*Saville-Kent*); Samoa and "South Seas" (*Strassburg Museum, Ortmann*).

Madrepore tenella.

Corallum much flattened, flabellate; allied to *M. elegans*, Ed. & H., but more delicate, and the marginal branchlets are not flattened. Main branches 7 millim. broad, rarely over 3 millim. thick, somewhat sinuous, the subdivisions and corallites almost all lateral. Simple lateral corallites give rise by increase in size and the development of buds to twigs ranging from 5 millim. to 4 centim. in length, the larger ones again divaricately divided. Apical corallites 1 to 1.5 millim. diameter, a little compressed, usually 3 millim. exsert. Lateral corallites distant, compressed; nariform at first, but soon becoming tubular and very spreading, diameter 1 millim., length 1 to 5 millim., those which are longer bear buds. There are no immersed corallites, and in this species the upper as well as the lower surface of the main divisions is usually void of corallites of any kind. Star moderate.

Macclesfield Bank, 31 and 37 fathoms (*H.M.S. 'Penguin'*).

Madrepore tizardi.

Madrepore nasuta, B.-Smith (non Dana), Ann. Mag. N.H. vol. vi. 1890, p. 453.

Madrepore effusa, B.-Smith (non Dana), loc. cit. p. 454.

? *Madrepore plantaginea*, B.-Smith (non Lamarck), loc. cit.

? *Madrepore valida*, B.-Smith (non Dana), loc. cit.

Corallum corymbose, a little convex above; under surface oblique, reticulate or almost solid, with short stunted twigs in the general plane, provided with a few scattered verruciform and immersed corallites in reticulate specimens. Branchlets erect and relatively slender and elongate in some specimens, but shorter and stouter in others; apices about 1.2 centim. apart; length 4 millim., diameter 6 to 8 millim., or 1 centim. in stunted forms. Apical corallites 2 millim. diameter, cylindrical. Lateral corallites ascending and distant, dimidiate, gutter-shaped and hooked nariform, with the outer margin curved; those below are dilated, verruciform, with the aperture opening inwards; all are immersed at the base of the branchlets; length very variable, usually 2.7 to 4 millim., diameter about 1.6 millim., but all the more prominent ones are distinctly compressed. At intervals elongate, compressed, tubular corallites, with oblique apex, occur, which indicate new outgrowths. Walls a little thickened and very dense. Star moderately developed.

Tizard Bank, 5 fathoms (*H.M.S. 'Rambler'*); Macclesfield Bank, 13 fathoms (*H.M.S. 'Penguin'*).

Madrepora violacea.

Corallum cespitose or subcorymbose from an incrusting base. Branches short, stout, and much divided, somewhat angular near the base; main divisions 2·5 to 3·5 centim. long, over 1 centim. diameter at a point 1 centim. below the apex. Axial corallites 2·5 to 3·5 millim. diameter, usually 1·5 millim. exsert, subconical, with a rounded margin. Lateral corallites chiefly stout, spreading, tubular, with smaller tubular, nariform, or subimmersed ones between; stout corallites sometimes in subregular rows, diameter 2 to 2·5 millim., length 2 to 4 millim., inner part of the wall often a little shorter than the outer, margin distinctly rounded; the longer ones bear buds. Wall dense and thick. Star moderately developed in stout corallites, but scarcely recognizable elsewhere.

Fiji (*Rayner*); Great Barrier Reef (*Saville-Kent*); Macclesfield Bank, 7 to 8 and 13 fathoms (*H.M.S. 'Penguin'*).

LVII.—*Description of a new Species of Slug from South Africa.* By EDGAR A. SMITH.

THE British Museum has recently received from Mr. J. H. Ponsonby a very remarkable slug which was collected near Pietermaritzburg (Natal) by Mr. H. Burnup.

It belongs to the genus *Apera**, of which only a single species has as yet been described. This group originally bore the name of *Chlamydephorus*†; but as that term had previously been employed in Mammalia‡, that suggested by Heynemann may be conveniently substituted. Heynemann, however, does not appear to have been aware that Agassiz had used the name *Chlamydephorus*, which is practically the same as Binney's *Chlamydephorus*, but abolished Binney's name on the ground that it indicated a false characteristic, namely the presence of a mantle. On the contrary, Heynemann considered that the pallium was entirely wanting or concealed, and hence he proposed the term *Apera*.

* Heynemann, Jahrb. deutsch. Mal. Gesell. 1885, p. 20.

† Binney, Bull. Mus. Comp. Zool. Harvard, vol. v. (1879), p. 331.

‡ Agassiz, Nomen. Zool. Mammal. p. 8 (1842).

The known species *A. Gibbonsi* also occurs in South Africa.

Apera Burnupi.

Corpus (in alcoh. serv.) mediocriter elongatum, quadratum, postice leviter dilatatum, antice parum attenuatum, superne utrinque dorsum carinatum, carina secunda prope pedem, a capite ad longit. totius $\frac{2}{3}$ extendente, utrinque instructum, undique granulatum, sordide luteum, maculis punctisque nigris copiose pictum; dorsum inter carinas concavum, striis duobus parallelis a capite usque ad extremitatem caudæ sculptum, striis foramine radiantibus ornatum; latera æque concava; caput obtusum; tentacula contracta; pes luteus, immaculatus, marginibus distinctis circumscriptus; testa tenuissima.

Longit. 28 millim., diam. 8; foramen ab extremitate ad 8 millim. situm.

The quadrate form of this remarkable animal at once distinguishes it from any other slug. The keel or angle which limits the back on each side extends from the head to the posterior extremity. On the other hand the lateral keels or ridges, a little above the foot, reach about two thirds along the sides, commencing at the head. What appearance these carinæ may present when the animal is living is uncertain; but doubtless they are much accentuated by contraction in spirit.

The concave back widens a trifle posteriorly and then curves in to a terminal point. The foramen is situated in the centre of this expansion, and from it radiate impressed striæ in all directions, and those which pass beyond or cut across the marginal keels give them a scalloped appearance. The entire surface is coarsely granular and covered with more or less anastomosing impressed lines; two, parallel to each other and about a millimetre apart, run down the middle of the back from end to end; a single more or less distinct line can also be noticed along each side between the keels. All the tentacles are completely retracted beneath the skin, and no genital opening behind the right one is observable. Apparently there is no caudal pore. The foot is broad, has a distinct margin, and occupies almost three fourths of the entire width of the animal.

On cutting the skin near the dorsal opening a shell as thin as paper was discovered. It was white, calcareous, and broken up, but probably in life would be entire.

LVIII.—*A Criticism of a Modern Hypothesis of the Transmission of Hereditary Characters.* By R. S. BERGH, of Copenhagen *.

IN the following pages it will be my endeavour to refute an hypothesis which has been disseminated exceedingly widely during the last six or seven years and is often designated as the "Theory of Heredity." I am unfortunately at present unable to advance the subject by new observations of my own, and still less can I introduce a fresh hypothesis by way of compensation. Nevertheless this essay will not be altogether useless, since the hypothesis in question is nowadays supported by the most distinguished investigators and is even represented in text-books as a proved reality, and because the arguments upon which it is based, in spite of the conspicuous importance of the matter, are nowhere discussed in detail from the opposition side. I have for a long time been an opponent of this hypothesis by reason of previous knowledge; thus in my lectures upon general embryology † I have already represented this matter from another point of view, and I took up a position still more decisively opposed to the theory in my addresses upon General Histology ‡. And now an investigator, whose knowledge of the processes of fertilization entitles him to the highest consideration, has this year published a paper § which shows in the clearest manner that the theory alluded to was built upon sand.

The hypothesis which we have to discuss may be summed up in a very few words: it really consists only in the supposition that the nucleus (or, as certain authors imagine, the chromatin itself) is the sole substance which has a part to play in the transmission of hereditary characters, and that consequently the cell-substance, or whatever lies outside the nucleus, is of no importance in the connexion named. Among the very numerous representatives of this doctrine let us here mention only a few of the most important:—O. Hertwig ||

* Translated from the 'Zoologischer Anzeiger,' xv. Jahrg., no. 388 (Feb. 1, 1892), pp. 43-52.

† These appeared in print in February 1887.

‡ In the autumn of 1889; not yet published.

§ H. Fol, "Die Centrenquadrille, eine neue Episode aus der Befruchtungsgeschichte," Anatomischer Anzeiger, 6 Jahrg., 1891, nos. 9, 10.

|| O. Hertwig, "Das Problem der Befruchtung und die Isotropie des Eies, eine Theorie der Vererbung," Jenaische Zeitschr. N. F., 11 Bd., 1884.

(1884), Strasburger* (1884), Weismann† (1885), Kölliker‡ (1885), van Beneden§ (1887), Weigert|| (1887), and Boveri¶ (1889). Kölliker, in his 'Handbuch der Gewebelehre' (6 Aufl., 1889), states the theory with great confidence; and in 1890 Bütschli** also, who formerly held similar views to my own on the question, was converted to it in consequence of an experiment by Boveri, which will be discussed more closely below. Only isolated sceptics declared from time to time in quite general terms that the positive foundations of this hypothesis were too weak; thus this view was already expressed by Hensen†† in the year 1885, and subsequently also by Whitman‡‡ and Waldeyer§§; these remarks, however, were passed over in silence by the representatives of the "Theory." So far as I am aware no one has as yet expressed himself in emphatic opposition to the theory; this is indeed intelligible when we consider how great is the weight of authority by which it is supported.

In the first place let us draw attention to the important difference between the original idea of Nägeli||| upon the subject of idioplasm and nutritive plasm in their relation to heredity and the ordinary theory which is here under discussion. From the fact that spermatozoon and ovum, in spite of their enormous difference in size, take an equal share in the transmission of parental characters, Nägeli concluded that the matters which are of importance for the phenomenon of

* Strasburger, 'Neue Untersuchungen über den Befruchtungsvorgang bei den Phanerogamen als Grundlage für eine Theorie der Zeugung' (Jena, 1884); 'Ueber Kern- und Zelltheilung im Pflanzenreiche, nebst einem Anhang über Befruchtung' (Jena, 1888).

† Weismann, 'Die Kontinuität des Keimplasmas als Grundlage einer Theorie der Vererbung' (Jena, 1885).

‡ Kölliker, "Die Bedeutung der Zellkerne für die Vorgänge der Vererbung," Zeitschr. f. wiss. Zool., 42 Bd. (1885).

§ E. van Beneden and A. Neyt, "Nouvelles recherches sur la fécondation et la division mitotique chez l'*Ascaride mégalocéphale*," Bull. de l'Acad. de Belgique, sér. 3, t. xiv. (1887).

|| Weigert, "Neue Vererbungstheorien," Schmidt's Jahrb. d. gesammten Medicin, 215 Bd. (1887).

¶ Boveri, "Ein geschlechtlich erzeugten Organismus ohne mütterlichen Antheil," Sitzungsber. d. Ges. f. Morphol. u. Physiol. in München, 5 Bd. (1889).

** Bütschli, 'Ueber den Bau der Bakterien u. verw. Organismen' (Heidelberg, 1890).

†† V. Hensen, "Die Grundlagen der Vererbung nach dem gegenwärtigen Wissenskreis," Landwirthsch. Jahrbücher, 14 Bd. (1885).

‡‡ Whitman, "The Seat of Formative and Regenerative Energy," Journal of Morphology, vol. ii. (1888).

§§ Waldeyer, "Ueber Karyokinese und ihre Beziehungen zu den Befruchtungsvorgängen," Arch. f. mikr. Anat., 32 Bd. (1888).

||| Nägeli, 'Mechanisch-physiologische Theorie der Abstammungslehre' (München. 1883).

heredity are present in relatively far greater abundance in the spermatozoon than in the ovum, and that by far the greatest mass of the ovum consists of nutritive plasm. Now the newer doctrine maintains that those matters which are active in heredity are situated in the nucleus alone, and the demonstration of such a transmitter of hereditary characters, the existence of which is not merely inferred, but which is actually visible, has usually been regarded as an important advance. In my opinion such a display of precision should rather be termed a retrocession or deviation; for Nägeli's idea was simply a delicate logical construction which was thoroughly consistent with the facts, and its justice has subsequently been proved most unmistakably by the experiment of Boveri, to which reference shall shortly be made. For the more modern view, on the contrary, not only were the actual starting-points too slight, but many facts made themselves felt against it even at the time; that it is untenable as a theory is moreover demonstrated by the above-mentioned communications from Fol.

I shall now adduce the chief arguments which are brought forward in favour of the doctrine of the seat of the processes of heredity in the nucleus and give an analysis of each.

In the first place it is alleged as the chief reason that the heads of the spermatozoa consist solely or almost solely of nuclear substance, and that this is the only portion of the spermatogenic elements which is active in the process of fertilization. Kölliker goes furthest in this respect, since he declares the spermatozoa of certain animals to be simply nuclei. The majority of investigators do not follow him in this, doubtless partly because we otherwise know nothing of an existence and activity of naked nuclei, and because the greater number of those who have watched the process of spermatogenesis have maintained the cellular nature of the spermatogenic filaments. Moreover, most of the adherents of the theory which is here to be criticized assume the presence of an extremely thin protoplasmic envelope round the nucleus of the spermatozoon, even when such an envelope is hardly to be detected or is absolutely invisible, thus allowing the tail of the spermatogenic filament to rank as protoplasm; and at any rate in the process of fertilization the layer surrounding the nucleus must penetrate with it into the ovum, as has indeed positively been proved to be the case in certain instances. But, in addition to this, the following also must be conceded: the spermatozoa arise from cells through repeated indirect nuclear division (and finally cell-division). Now recent investigations have shown that in indirect nuclear division the so-called polar bodies or "centrosomata" (*Centrosomen*) are of quite general

occurrence, and these have also been proved to appear, at any rate in certain cases, in spermatoblasts *. Let us now consider how long it has taken to increase our knowledge with regard to these bodies; let us further consider that it is now gradually becoming possible to demonstrate the existence of centrosomata in resting-cells also; let us, moreover, remember how greatly reduced in size the nucleus of the spermatozoon usually is, and how difficult it must be to prove the presence of a centrosoma in the spermatozoon should its bulk be proportionately diminished †; finally, let us reflect that a centrosoma and a star-shaped figure appear near the male pronucleus in the ovum. On considering all these points the idea soon suggests itself that this centrosoma originates from the spermatoblast and was present in the spermatozoon also, although it is not always possible to demonstrate its existence. As a matter of fact the origin of the centrosoma from the protoplasm of the spermatozoon was actually maintained by Boveri ‡ also—an hypothesis which Kölliker imagined he could “pass over in silence” (*Gewebelehre*, p. 67). That Boveri’s view nevertheless contained a grain of truth is shown by the investigations of Fol (*cf.* below). It is also possible to arrive at a similar conclusion with reference to the ovum. In the formation of the “directive bodies” very distinct star-shaped figures appear both proximally and distally in the majority of ova, from which we are entitled to infer the existence of centrosomata, the more so since these have been positively demonstrated in certain cases §. Consequently besides the female pronucleus a centrosoma must have remained behind in the ripe ovum.

As another argument in favour of the theory it is usually alleged that the nucleus exercises a leading or directing influence in cell-division; but it is altogether impossible to prove this with reference to the cases which have been most closely investigated. I will merely adduce the following instance:—In the first two segmentation spheres of *Ascaris megalocephala*, with regard to which the excellent investigations of van Beneden and Neyt, as also those of Boveri, are available, the centrosomata divide, even before the nuclear contents have differentiated into loops and the archoplasm (“sphère attrac-

* *E. g.* by O. Hertwig (*“Vergleich der Ei- und Samenbildung bei Nematoden,” Arch. f. mikr. Anat., 30 Bd., 1890.*)

† It has recently been proved by an important paper by Platner that centrosomata actually occur in the spermatozoa of certain mollusks (*Arch. f. mikr. Anat., 33 Bd., 1889.*)

‡ Boveri, *“Zellen-Studien,” 2 Heft (Jena, 1888).*

§ *E. g.* in the case of *Limax* by E. L. Mark (*Bull. Mus. Comp. Zool. Harvard College, vol. vi. no. 12, 1881.*)

tive") has divided, and before the longitudinal fission of the loops has taken place. The case is also precisely similar, according to Kölliker's own statement, in the segmentation spheres of the *Axolotl*; moreover, according to Rabl*, in the epithelial cells of *Salamandra* the achromatin spindle is distinctly visible, and consequently the centrosomata have in all probability divided, before the occurrence of the cleavage of the chromosomata.

This at once weakens everything else which is asserted by Kölliker and Weigert with respect to the importance of the nuclei for the growth and metabolism of cells. Probably no one will nowadays deny that the nucleus is of eminent importance for the processes of growth, assimilation, and secretion in cells. This, however, proves nothing whatever with regard to the question whether the nucleus is the sole agent in heredity. And with regard to the circumstances which have been rendered applicable by Strasburger from the botanical side, I think that I may here leave these out of consideration, because until recently hardly any attention has been paid to the centrosomata and their rôle in the cells of plants. It was not until the present year that the fact that they are of general occurrence here also was maintained by Guignard†.

We now come to the argument, which nowadays probably ranks as the most important of all, as the actual experimental basis of the theory, in consequence of which even so independent and far-sighted an investigator as Bütschli found himself compelled to alter his views. This is the attempt of Boveri, of which mention has already several times been made, to produce an organism devoid of maternal characters. Boveri found that, in *Echinids*, fragments of ova devoid of nuclei (obtained by shaking) are capable of being fertilized and developing into larvæ. He further makes use of the experience obtained by O. and R. Hertwig as to hybridization in these animals: on fertilizing the ova of one species (A) with the spermatic fluid of another (B), larvæ are formed which are intermediate in character between the typical larvæ of A and B. Boveri now fertilized an egg-fragment of A, from which the nucleus had been eliminated by the process of shaking, with sperm from B, and it was found that a larva developed which entirely possessed the characters of the

* C. Rabl. "Ueber Zelltheilung," *Morphol. Jahrbücher*, 10 Bd. (1884).

† Guignard, 'Comptes Rendus,' March 9, 1891. I became acquainted with this paper through a statement by van Tieghem in the 'Journal de Botanique,' 5 année, no. 7, p. 101; for the reference to this I am indebted to my friend Dr. Kolderup-Rosenvinge.

typical larvæ of B, and consequently was "devoid of maternal participation." This experiment of Boveri's is ingeniously carried out and very instructive; but it in no way proves what the author himself* and many other investigators maintain. It demonstrates that the yolk of the ovum (not merely the nutritive, but also the formative yolk—apart from the centrosoma) is of no importance for the transmission of parental characters, and consequently substantiates Nägeli's doctrine of the difference between idioplasmic substances and those consisting of nutritive plasma. But the experiment in no way proves that the nucleus is the sole vehicle of heredity; for in his memoir on this subject Boveri makes no mention of the centrosomata, which is the more astonishing since he belongs to the investigators to whom credit is due for the recognition of the importance of these bodies. But now it is clear, since the division of the cells took place in the normal course, and a typical larva was developed, that centrosomata were present in the fertilized egg-cell and in the segmentation cells. Whence did these arise? It is well known that the centrosomata, in cases where they have been shown to exist in the resting-cell, are always situated in the immediate neighbourhood of the nucleus; and it is therefore in the highest degree probable that the centrosoma of the ovum was eliminated with the nucleus by the process of shaking, and that the new centrosomata, which displayed their activity in the fission of the egg-cell, developed from the spermatozoon which penetrated the latter. Fol's observations in particular, which we shall discuss directly, render this explanation very probable, and indeed they show that it is really the only possible one. In order to prove the theory that the hereditary characters are situated in the nucleus, a corresponding experiment would have to be carried out in the following manner:—The ovum of a species (A) must be deprived of its nucleus, but must retain its centrosoma. Then if, after fertilization with the sperm of another species (B), a larva developed which agreed in all its characters with the typical

* At the commencement of his communication Boveri writes:—"Although the proposition, that the substances of the cell which determine and transmit character are exclusively contained in the nucleus, is expressed in many places no longer merely as a highly probable hypothesis, but already as a fact, it would nevertheless be easy to show that it can neither be proved by the phenomena of the fertilization of the ovum, with which we are acquainted, nor by the experiments which have hitherto been instituted upon the rôle of the nucleus in the Protozoa." And after communicating his experiment he then says:—"Thereby also the proposition, that the nucleus is the sole vehicle of heredity, is proved."

larva of B, I should know of no further objection to raise. This experiment, however, would be difficult to perform. Consequently Boveri's experiment, as it at present stands, proves, as I have already said, only the theory of Nägeli, and not that of Kölliker, Hertwig, and others.

Lastly, I have yet to speak of one or two other experimental investigations—"Attempts at artificial fission and regeneration of Protozoa,"—and to analyse the conclusions which have been deduced from them. It has been shown by very instructive experiments on the part of Nusbaum*, Gruber†, and Balbiani‡, that non-nucleated fragments produced by cutting-up Infusoria, even when they remain alive and capable of movement for some days, are nevertheless unable to feed, increase in size, and regenerate the lost parts, while those fragments which contain a portion of nucleus do this readily. The facts in question are interesting, since they prove that protoplasm is not capable of permanent existence when deprived of its nucleus, just as we are unacquainted with cases in which isolated nuclei are viable. But it is an unjustifiable and illogical conclusion to suppose, as, for instance, Weismann maintains ('Keimplasma,' p. 29), that these experiments show that the nucleus is the sole vehicle of heredity and the sole formative element of the cell—for to say that the nucleus is indispensable for the formative processes is very far from asserting that it alone is indispensable. In dwelling a moment longer upon the Protozoa, the following remark may be made: it is stated by Kölliker ('Gewebelehre,' p. 67) that in *Euglypha* the polar body is attached to the nucleus. I do not know whether Kölliker was led to make this assertion by his own observations; he at any rate makes no mention of this. But we find it stated by Schewiakoff§, who was the first to demonstrate the existence of these bodies in the case of the Protozoa in the Rhizopod in question, that the polar bodies lie not in the nucleus, but in the substance of the cell, pressed into a hollow of the nuclear membrane; and this author is also of opinion that they arise, at least in part, from "the differentiating cytoplasm." Beyond this these bodies are not yet known in the Protozoa, and before their existence has been

* M. Nusbaum, "Ueber die Theilbarkeit der lebendigen Materie," Arch. f. mikr. Anat. 26 Bd., 1886.

† A. Gruber, "Ueber künstliche Theilung bei Infusorien" (I, II.), Biol. Centralbl. 4 & 5 Bd. 1885.

‡ Balbiani, "Recherches expérimentales sur la mérotomie des Infusoires ciliés," Recueil Zool. Suisse, t. 5, 1889.

§ Schewiakoff, "Ueber die karyokinetische Kerntheilung der *Euglypha alveolata*," Morphol. Jahrb. 13 Bd., 1888.

proved it would be premature to enter into a discussion as to what is the *primum movens* in the fission of the Infusoria. I have, however, really no doubt that sooner or later corresponding structures will be found in these forms also.

Until quite recently great uncertainty prevailed as to the origin of the polar bodies or centrosomata in the fertilized ovum. Many authors made no precise statements at all on the point. Boveri's hypothesis, according to which they arise from the protoplasm of the spermatozoon, has already been alluded to. This year this deficiency in our knowledge was supplied by the new investigations of Fol upon the ova of Echinids, and thus the last vestige of foundation was withdrawn from the theory that the nuclei are the sole vehicles of heredity. Fol's memoir marks, so to speak, the last stage in the present purely morphological knowledge of the process of fertilization. The investigator alluded to examined the fertilized ova of Echinids (as also those of other types) by means of thin sections, with the following results:—On the penetration of the spermatozoon into the ovum, its tip separates from it, and forms the "spermocentrum" (the polar body which precedes the male pronucleus); this, as well as the "ovocentrum," which was pre-existent in the ovum beside the female pronucleus, having arisen from the directive amphiaster, elongates into a dumb-bell shape, when the pronuclei have come together*, and undergoes division. A migration of the halves resulting from the fission now takes place, in such a way that each half of the spermocentrum finally comes into contact with a half of the ovocentrum and fuses with it. The bodies which are thus constituted, each of which consists of a male and female half, are the polar bodies or centrosomata ("astrocentres" of Fol) of the first segmentation amphiaster. For the present these are the only conclusions which Fol deduces from his investigations:—"Fertilization consists, not merely in the aggregation of two pronuclei, which proceed from individuals of different sexes, but also at the same time in the union of two pairs of half-centres ('Halbcentren'), of which one unit is derived from the father and the other from the mother, to form two new bodies—the astrocentres. Since all the astrocentres in an individual presumably originate through fission from the two centres of the first amphiaster, they all proceed in equal portions from the father and the mother."

Now if anyone, on the basis of these results, were to maintain, in an assemblage of zoologists, that the centrosomata

* Fol agrees with van Beneden in stating that in the normal course no fusion of the pronuclei takes place,

are the sole vehicles of heredity, he would probably be received, and justly, with general derision. I, however, maintain that if, for the present, anyone continues to assert that the nucleus is the sole vehicle of heredity, his hypothesis is of no greater value than that just mentioned.

The above conclusions and remarks will perhaps appear to unprejudiced investigators to be somewhat self-evident. That they were nevertheless not entirely superfluous is proved to me by a new paper by Weismann*, which actually appeared during the preparation of this little essay. For, in spite of cognizance of Fol's investigations, this author stands fast by his old opinions, and indeed is rather inclined to regard the former as a confirmation of his views. He would most of all prefer to consider the centrosomata as parts belonging to the nucleus; but here he will scarcely meet with the approval of specialists. And as for his other proposition, that the activity of the centrosomata is to be regarded as determined and guided by the nucleus, it is wholly artificial and arbitrary; indeed it has been demonstrated above that there is not the slightest foundation for such a supposition. We are fully entitled to ask, Why is not the position reversed? Why is not the activity of the nucleus equally well to be regarded as dependent upon that of the centrosoma?

In the present state of the case it would be much better to say, the theory that the nucleus alone is the seat of the processes of heredity was premature, and provisionally we know nothing about it. But if we wish to express conjectures, it is much more probable that the processes of heredity, as well as most of the other vital processes in the cell, depend upon intimate relations between nucleus and plasma (or, to be precise, the directing portion of the plasma—the centrosoma), and that in this respect we have no reason to favour one of these parts more than the other.

Copenhagen, November 1891.

LIX.—*Description of a remarkable new Semnopithecus from Sarawak.* By OLDFIELD THOMAS.

MR. CHARLES HOSE has kindly submitted for my examination the flat skin of a monkey obtained by him some years ago on the coast of North-eastern Sarawak, and this proves to represent a species not merely new, but entirely different in its coloration from anything previously described. Among the many

* A. Weismann, 'Amphimixis oder die Vermischung der Individuen, Jena, 1891.

Semnopithecus known there are species whose colour is red, red and white, black and white, and wholly black; but, so far as I know, no species as yet described, with one exception*, shows a combination of all three colours—black, red, and white—as is the case with the present species.

This striking animal I propose to name

Semnopithecus cruciger, sp. n.

Fur long and soft on the head and shoulders, shorter elsewhere. Hairs of crown especially long, standing vertically upright everywhere, so that there are no centres of convergence or divergence, but that along the median line is somewhat longer than that on the sides, and there is therefore an ill-defined crest. Colour of crown, sides of body from axillæ, haunches, and outer sides of legs to ankles brilliant red, rather more chestnut on the head and paler on the lower legs. Hands, outer sides of arms to the shoulders, nape, and a central line (nearly 2 inches broad) down the back from the withers on to the base of the tail deep glossy black, a few inconspicuous yellowish or reddish hairs being, however, intermixed with the black. Upper surface of feet also black. It results from this arrangement of colours that when the animal is laid prone, with its arms and legs extended, the black of the arms and back forms a conspicuous black cross on a brilliant red ground, the latter colour extending from the sides down the legs, and being again bounded by the black feet.

Eyebrows black, contrasting markedly with the red forehead; short hairs of face, whiskers, hairs on ears, sides of neck, whole of chin, chest, and belly, and lines down inner sides of arms to wrists and legs to ankles glossy white, with a faint yellowish suffusion.

Tail above black basally, gradually becoming dirty yellowish brown distally; beneath white, becoming duller at the tip.

The type specimen being a flat skin, with the extreme tip of the tail imperfect, it is impossible to give any trustworthy measurements†, but the species seems to be decidedly smaller than either *S. cristatus* or *S. Hosei*—both found in the same district.

The specimen was shot by Mr. Hose in 1887 on the sea-

* *S. chrysogaster*, see below.

† In the bones of the foot the distance from the back of the calcaneum to the end of the second phalanx of the middle toe is 130 millim. The epiphysial sutures are still just visible.

coast at a place called Miri, North-eastern Sarawak, some sixteen miles south of the mouth of the Baram River.

No species appears to have ever been described at all resembling this remarkable animal. Its nearest ally is perhaps that figured by Peters * under the name of *S. chrysogaster*; but even this relationship is very doubtful, the different distribution of the colours and the conspicuous difference in the colour of the crown widely separating the two forms.

LX.—*Description of a new Mexican Bat.*

By OLDFIELD THOMAS.

THE British Museum has received from Dr. A. C. Buller two bats belonging to the group called *Rhogeessa* by Dr. H. Allen, but clearly differing from *Rh. parvula*, the only species of the group recognized by Dr. Dobson, by whom also the group itself was placed simply as a subgenus of *Vesperugo*. This reference I am not disposed to endorse, and think that it should rather be looked upon as related to *Nycticejus*, with which it agrees in the number of its incisors and premolars, and from which it differs mainly by the cylindrical form of its outer lower incisors. Pending, however, a renewed revision of the whole group I propose to use the term *Rhogeessa* in a generic sense. The new species, which appears to be of a somewhat annectant nature, I propose to dedicate to Dr. Harrison Allen, the chief authority on North-American bats and the founder of the group to which I refer it.

Rhogeessa Alleni, sp. n.

Decidedly larger than *Rh. parvula*; muzzle obliquely truncate as in that species. Ears large, laid forward they reach about 1 or 2 millim. beyond the nostrils; their inner margin very convex forwards below, straight or even slightly concave above; tip narrowly rounded off; outer margin concave below the tip, then straight, becoming slightly convex below, outer basal lobe but little marked. Tragus long, its broadest point opposite to base of its inner edge; inner edge straight or slightly concave, tip rounded, outer margin slightly convex, the edge indistinctly crenulate, somewhat as in *Antrozous pallidus* †; a marked lobule at the base of the outer margin, above and below which there is a concavity. Thumb very short and thick, no longer than in *Rh. parvula*.

* MB. Ak. Berl. 1879, pl. iv. a.

† There is also a slight crenulation in *Rhogeessa parvula*.

Posterior edges of wing-membrane bordered with white; bifid tip to fourth finger unusually distinct*; wings from the base of the fifth toe; post-calcareal lobe small and narrow; tip of calcar projecting slightly from the back of the membrane; tail included in membrane to the extreme tip.

Teeth.—Upper incisors one on each side, long, slender, unicuspid; upper premolars large, quite close to the canines; no trace of a minute anterior premolar. Lower incisors six, the four median ones broad, tricuspid; the outer ones unicuspid, exceedingly minute, practically invisible from in front, and scarcely one twentieth of the size in cross section of the median incisors; far smaller therefore both absolutely and relatively than in *Rh. parvula*.

Dimensions of the type (an adult female in spirit):—

Head and body 47 millim.; tail 41; ear, above head 12·2, from notch 16; tragus, inner margin 7; forearm 35; thumb 5; metacarpal of third finger 33·5; lower leg 15·5; hind foot 7·1; calcar 15.

Skull of a second specimen: occiput to gnathion 14·7; greatest breadth 9·5; distance from front of canine to back of $\frac{m}{3}$ 5·4.

Hab. Santa Rosalia, near Autlan, Jalisco, Mexico.

This interesting species shows a relationship to *Nycticejus humeralis*† and to Old-World *Nycticeji* by its dental formula and the unicuspidate character of its upper incisors; to *Rhogeessa* by its obliquely truncated muzzle and its cylindrical $\frac{1}{3}$; and finally to *Antrozous* by its crenulate tragus and by the extreme reduction of the same $\frac{1}{3}$, which is altogether absent in that genus.

BIBLIOGRAPHICAL NOTICES.

Fur-bearing Animals in Nature and in Commerce. By HENRY POLAND. Gurney and Jackson.

WE are told in the preface that this “work is intended, firstly, to aid persons engaged in trade to recognize readily and to have a closer knowledge of the animals with which they are to some extent already familiar, and which they would have some difficulty in finding in more elaborate and scientific works;” and in this respect

* This peculiar bifid tip to the fourth digit does not seem to have been often noticed, as I can find no reference to it, although it occurs more or less developed in *Rhogeessa*, *Antrozous*, *Nycticejus*, *Atalapha*, and certainly in some of the many species of *Vesperugo*.

† For nomenclature see Ann. Mus. Genov. (2) ix. p. 88, 1890; and Ann. & Mag. Nat. Hist. (6) vii. p. 528 (footnote), 1891.

it amply fulfils its promise. The statistics of the annual sales of furs by the Hudson's Bay Company from 1800 to 1890, as well as of other American and Canadian furs from 1763 to 1891, are very useful, and so are the short histories of the Skinners' and other companies, the descriptions of the arts of dressing and dyeing pelts, the observations on tariffs, and the notices of fairs and periodical sales. It is astonishing to find on unimpeachable evidence that the Hudson's Bay Company sold in 1886 no fewer than 73,878 skins, and in 1887 78,555 skins, of the lynx; and it would be interesting to know if, in those somewhat exceptional years of plenty, the periodical increase of the American rabbit, on which the lynx is known to prey large'y, had reached its maximum. Again, the wolverine or glutton enjoys the reputation of being the despair of hunters, taking their baits and springing their traps without, as a rule, falling a victim itself; yet even this cunningest of animals can be circumvented, as shown by the returns of the Hudson's Bay Company, which often exceed 2000 skins in a year, while in 1889, 1131 were obtained from other sources. These instances, out of many which might be adduced, will serve to show that the whole of the Introduction is replete with information; but in the second and principal portion of the work, which is intended "to be a connecting link between commerce and science," and to interest "the general public by adding small sketches of the habits of the animals described," the result is not so satisfactory. An undigested mass of notes made from time to time appears to have been sent to the printer; and although some of these notes are recent and valuable, while the author's remarks are of importance so long as he confines himself to the trade with which he is familiar, yet there are other statements which are very remarkable. It is startling to be told that seals are to be found in the "Balkan" (p. 214); that "in Scotland the Manes of the slain bear was [*sic*] exorcised by the women" (p. 161); and (p. 171) that the Indian sloth-bear "would probably interbreed with the black bear of America, and if the offspring of these two bears should prove fertile, it would necessitate their being classed as one species"! Without admitting the *sequitur* we will, in connexion with this subject, make Mr. Poland and our readers the present of an interesting fact which appears to have escaped the notice of the recorder of Mammalia in the 'Zoological Record' for 1888. Dr. Nills, the Director of the Zoological Gardens at Stuttgart, states that, having obtained two litters by crossing male *Ursus maritimus* with female *Ursus arctos*, he then crossed a female hybrid with male *U. maritimus*, and produced offspring exactly like the polar bear in shape and colour. Turning to the hyæna, Mr. Poland seems to be acquainted with only one species, namely the South African *H. crocuta*, for under this heading he tells us that "1650 hyænas were killed in British India in 1886," apparently without a suspicion that these must have been *H. striata*. It is a pity that the author did not secure the assistance of some zoologist, who would have struck out many of the errors and even absurdities which this book contains, especially in connexion with

sport; but then the book would not have been half so funny as it is—*e. g.* the articles on the fox and the otter. At the same time the work contains a large amount of information which could not easily be found elsewhere; it is well illustrated, and, inasmuch as its merits distinctly outweigh its defects, which are amusing, we may fairly recommend it, even to naturalists.

Horn Measurements and Weights of the Great Game of the World: being a Record for the use of Sportsmen and Naturalists. By ROWLAND WARD. Published by the Author, 166 Piccadilly.

It might be thought that a book which deals with the measurements of Great Game would prove interesting principally to the sportsmen whose trophies were therein recorded; but a wider circle will be attracted by this volume, inasmuch as it also appeals to the naturalist. The author modestly disclaims any pretensions to the production of a scientific work; but nevertheless this book deserves the notice of those scientific men who appreciate exactness, for, to quote the title of the diploma-picture of an eminent Royal Academician, "Science is Measurement." It is no small advantage to have at hand a volume to which reference can at once be made for the extreme as well as the average dimensions of the antlers of deer, the horns of sheep, wild goats, buffaloes, &c.; the substances popularly known as "horns" which grow on the snouts of rhinoceroses; the tusks of the hippopotamus, of the two existing species of elephants, and of the wild boar; and the skins of the lion and tiger. All these and many other interesting details are to be found in this profusely illustrated and handsome book. The descriptions of some of the rarer antelopes are likely to prove of considerable utility to zoologists; the geographical distribution of all the animals mentioned seems to be indicated with unusual accuracy; and much of the information conveyed is new or at least recent. For instance, it may safely be said that never before has such a record of the dimensions of the grand wild sheep of the Pamirs, *Ovis poli*, been accessible to naturalists. If we have to make a trifling complaint it is that the two undoubtedly distinct species of African rhinoceros are mixed up under the common heading of *R. bicornis*, with merely asterisks and footnotes to indicate the horns which are those of the almost, and perhaps quite, extinct *R. simus*. It is indeed grievous to think that, so far as we are aware, there is not in any collection a single adult example of this huge square-mouthed grass-eating species, which will only be known to the next generation by a very few horns and through old pictures. It is difficult to give suitable extracts from a work of this kind; but we can testify to its general merits, as well as to the manner in which the author has endeavoured to assist scientists by sending rare specimens to the British Museum and the Zoological Society for inspection and determination.

MISCELLANEOUS.

The Embryonic Development of Comatula (Antedon rosacea).

By OSWALD SEELIGER, of Berlin.

IN the following paragraphs I communicate some of the results of a detailed investigation the account of which will be published in Spengel's 'Zoologische Jahrbücher,' but cannot appear forthwith on account of the large number of plates.

Segmentation is unequal. The segmentation cavity appears at the stage with four blastomeres of equal size. The third and equatorial furrow differentiates four smaller cells, which are situated at the animal pole, and four larger vegetative ones. The smaller blastomeres next divide, and then the larger cells; the stage with sixteen cells is therefore preceded by one with twelve. Upon this there next appears round the animal pole a furrow running parallel to the equator, whereby sixteen equal-sized animal cells are formed, so that a stage with twenty-four cells is reached. In consequence of a mutual displacement of the small cells the segmentation cavity closes up at the animal pole, while the eight large cells become divided by an equatorial furrow into eight smaller and eight larger cells, situated at the vegetative pole. It is not until the stage at which forty-eight cells are present that the closure of the segmentation cavity at the vegetative pole ensues and a typical blastula is formed, the cells of which proceed to divide in such a way that sixty-four, ninety-six, and one hundred and twenty-eight cells are differentiated.

In abnormal cases the equatorial furrow is not the third but the first to appear, and segmentation commences with the formation of two cells of unequal size. The smaller cell then divides, so that the stage with two cells is followed by one with three. By the extension of the second and meridional furrow to the larger cell four blastomeres arise—two larger and two smaller ones. After each of these has divided by a second meridional furrow into two cells of equal size a stage with eight cells is produced, which then entirely corresponds to the normal development.

The gastrula arises by invagination at the vegetative pole in such a manner that the chief axis of the ovum precisely coincides with that of the embryo and of the subsequent larva. The mesenchyma arises from the endoderm.

It appears to me to be worth while mentioning an abnormal bigastric form of embryo, of which I found one example among normally developed blastulæ. In the elliptical germ two gastrula invaginations had developed and a number of mesenchyma cells had appeared at their blind ends. This latter circumstance excludes the suspicion that what was seen might possibly have been accidental incurvations of the blastula wall, which would afterwards be evaginated again: as is well known, this was the explanation given by Metschnikoff of Fol's polygastral embryonic forms of Echinoderms.

As regards the further development I shall confine myself here to treating of the nervous system. The free-swimming larva possesses

a nervous system of its own which is of merely provisional importance and which already begins to develop in the latter part of the embryonic period. At the anterior pole, which is distinguished by the tuft of cilia, a delicate system of fibres was observed by Bury, who conjectures that it is possibly nervous. The apparatus proves to be of a highly complicated character. The cells of this region, which we may term the apical pit, consist of sense-cells and undifferentiated supporting-cells. Both kinds of elements are rod-shaped, and their nuclei lie at somewhat variable altitudes near the inner ends. These latter appear to be blunt in the case of the supporting-cells, but in the sense-cells, on the contrary, are drawn out into a fine process which penetrates into the layer of the nerve-fibres. The nerve-fibre layer is of considerable thickness at the apex, but diminishes very rapidly towards the periphery; it is only on the ventral surface that a powerfully developed cord of fibres extends on each side of the vestibular invagination far into the posterior section of the body. Under the apical pit the layer of fibres is bounded towards the primary body-cavity and the mesenchyma cells by a basement membrane, which appears at a very early stage in the embryonic development. Even before the cells of the apical pit had attained their definite histological character, as supporting and sense-cells, numerous ectoderm cells separated from their connexion with the epithelium and wandered into the depths, to become transformed into ganglion cells, which lie above and between the layer of fibres. Isolated ganglion cells are also embedded in the two ventral longitudinal nerve-trunks.

Soon after the attachment of the larva the entire nervous system disappears, and it is not until much later, some two to three weeks after the attachment takes place, that there appears at the oral disk—which proceeds from the vestibular invagination—an extremely delicate nerve-ring, which is identical with the apparatus described by Ludwig as the sole nerve-centre of the adult form. It is of exclusively ectodermal origin, and beside the fibres scattered ganglion cells can be distinguished. I have not been able to follow up the origin of the second and third nervous systems of the adult, which were discovered by Carpenter and Jickeli, since in the oldest of the larvæ examined by me the rudiments of them were not yet visible.—*Zoologischer Anzeiger*, xv. Jahrg., no. 404 (Oct. 31, 1892), pp. 391-393.

On Deglutition in the Synascidiæ. By S. JOURDAIN.

The mechanism of deglutition in the Composite Ascidiæ, by which I mean the Ascidiæ Sociales of H. Milne-Edwards, is still imperfectly understood.

Several naturalists, applying to these animals what Hermann Fol found to be the case in *Doliolum*, have supposed that the nutritive particles follow the groove of the endostyle. This groove secretes a cylinder of mucus which agglutinates these particles and which, in consequence of the action of the vibratile cilia with which the groove is lined, descends towards and enters the stomach.

M. Giard, relying on experiments tried at Roscoff, by means of carmine administered to living Synascidians, has contended that deglutition takes place by the *dorsal* side, that is to say by the side opposite to the endostyle. This naturalist believes that the apparatus by the aid of which the act is performed is the series of dorsal languettes or the organs which represent them.

In *Clavellina* in particular these languettes, which are merely prolongations of the transverse bands of the left wall of the branchial sac, form a portion of a helicoidal surface upon which the food-particles glide until they gradually reach the stomach.

M. Giard sought to determine the point at which the secretion of the mucus takes place which envelops the nutritive particles. This substance cannot be formed along the spiral apparatus or the dorsal canal, for this region is devoid of glands. M. Giard therefore wonders whether the mucous matter does not proceed from the endostyle; nevertheless he does not explain how, according to this hypothesis, the mucus passes from the ventral surface to the opposite side.

On my part I have experimented upon living specimens of *Clavellina* and *Perophora*. In order to observe the mode of deglutition in these Ascidians it is sufficient, without having recourse to carmine, to place the living animal in sea-water containing a very small quantity of mud in suspension.

By this means we find, as stated by M. Giard, that deglutition takes place by the *dorsal surface*; only we discover at the same time that the alimentary cylinder neither coincides with the median line nor with the series of helicoidal languettes.

The very distinct track formed by the food-particles starts from the dorsal cup and proceeds in a somewhat oblique direction from top to bottom (I place the mouth at the top), at a slight distance from and to the right of the dorsal raphe.

By focusing the microscope accordingly, we observe in an individual lying on its left side first the body-wall and the branchial sac, then the nutritive cylinder, and beneath this the helicoidal languettes situated beyond the raphe.

This, then, is the way in which deglutition is effected:—

On a level with the peri-oesophageal nerve-ring there exists a band of vibratile cilia which conduct the nutritive particles towards an organ in the shape of a pit, which is ciliated and situated on the dorsal side in the neighbourhood of the cerebral ganglion. This pit secretes a large quantity of mucus, by which the food-particles are agglutinated together to form a cord, which descends towards the orifice of the stomach, following the course indicated above. The alimentary cylinder increases a little in diameter as it descends, and finally enters the stomach, the yawning aperture of which lies at the bottom of the respiratory sac.

One of the functions of the vibratile pit therefore seems to me to be established: it secretes the mucus by the aid of which the food-particles are agglutinated into a cord, which is conducted by a ciliated branchial band into the stomach.—*Bulletin de la Société Philomathique de Paris*, 8^{ième} série, t. iv. no. 1, 1892, pp. 35, 36.

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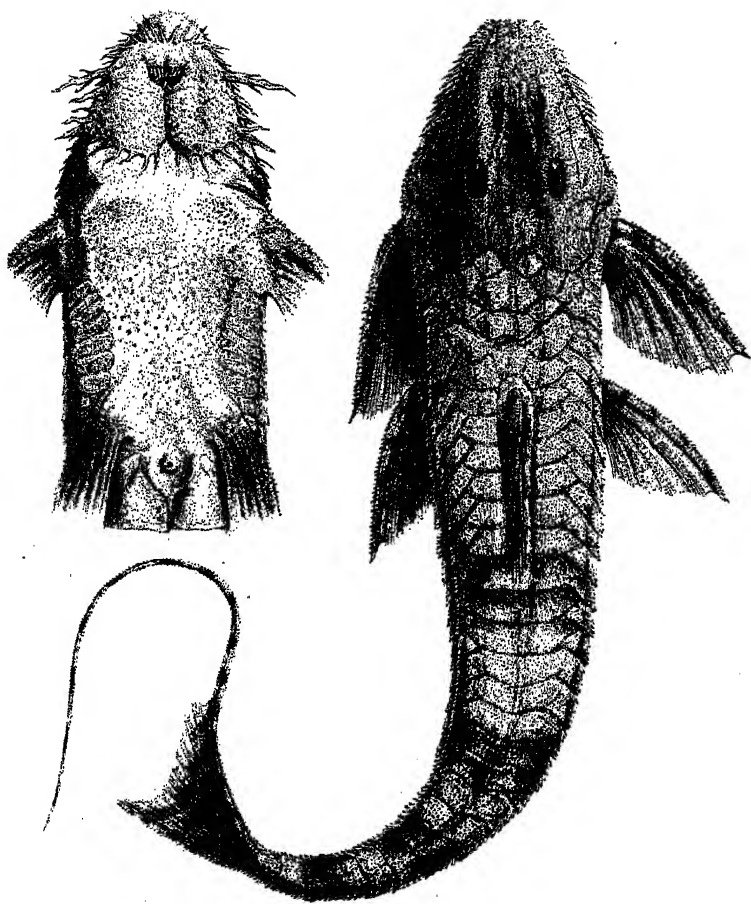
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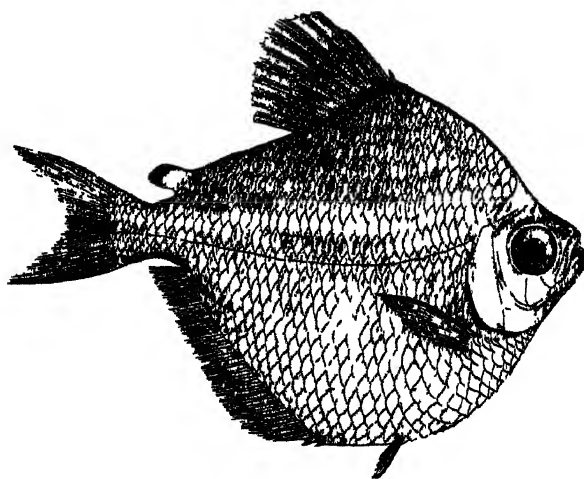
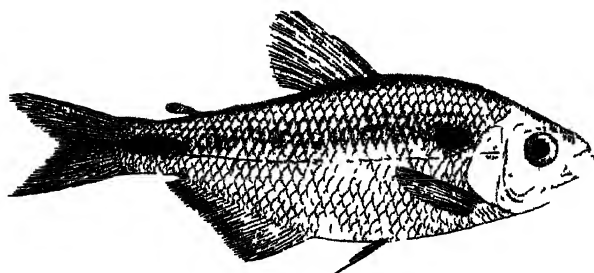
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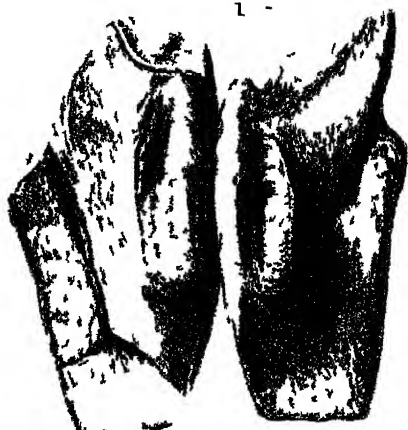
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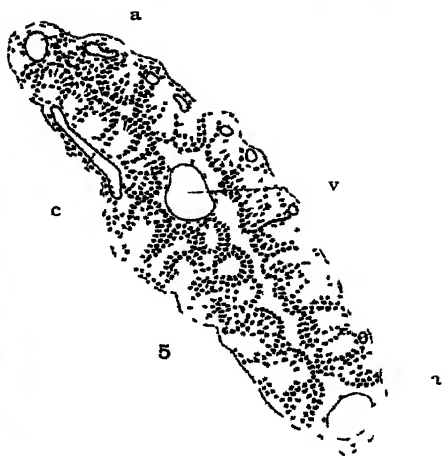
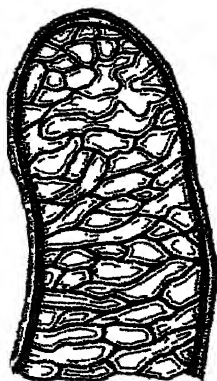
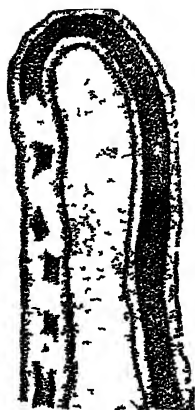


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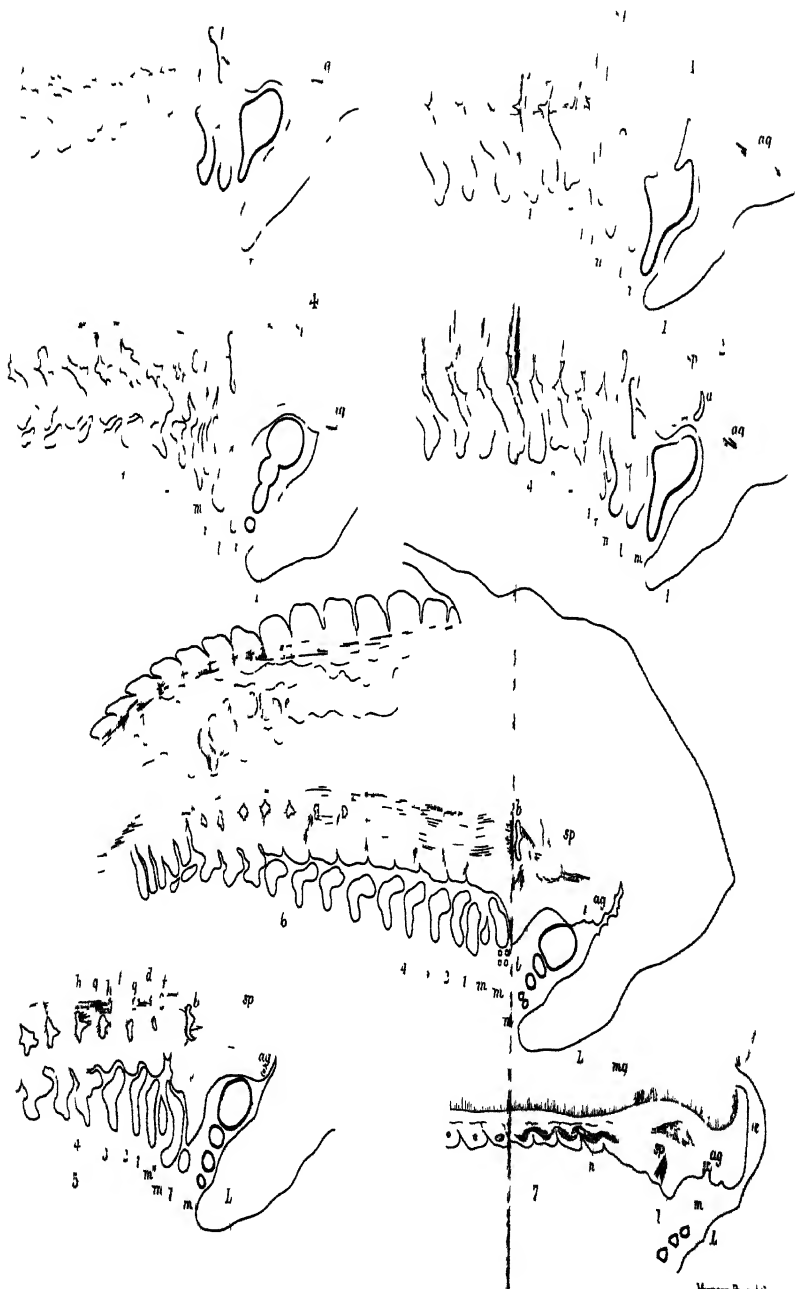


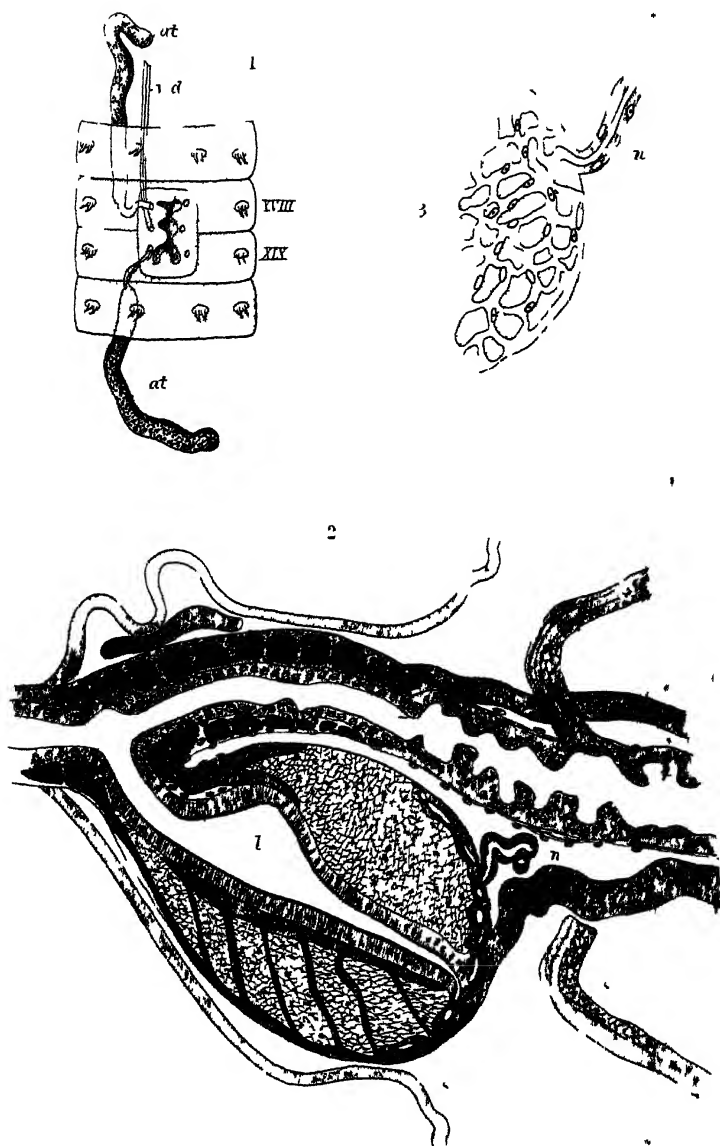
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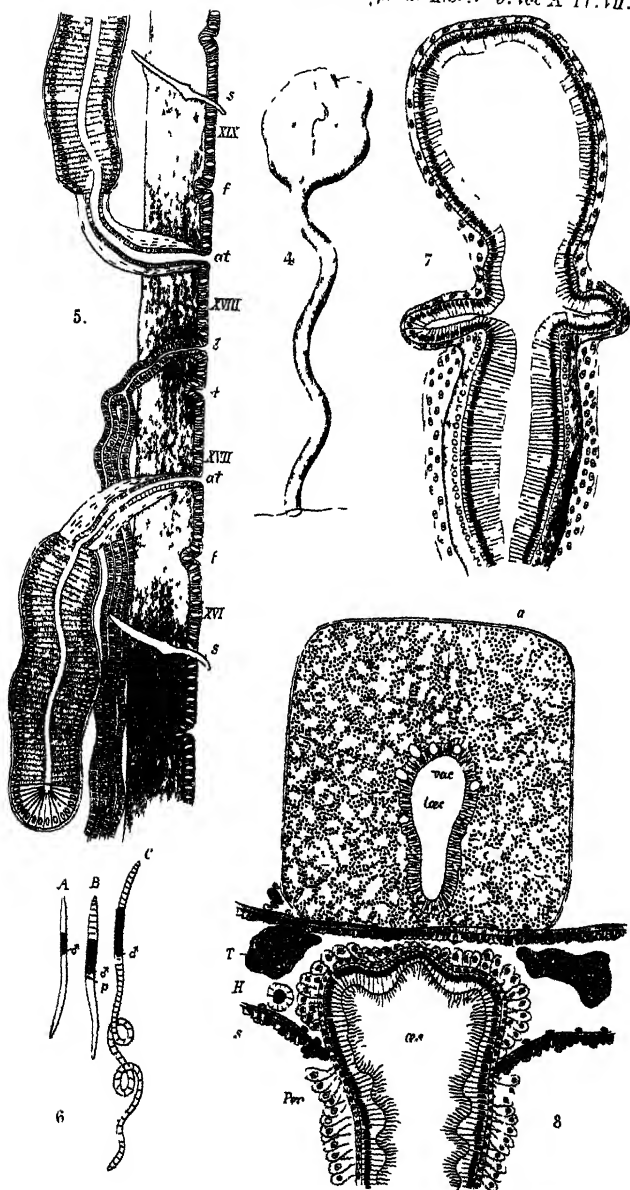
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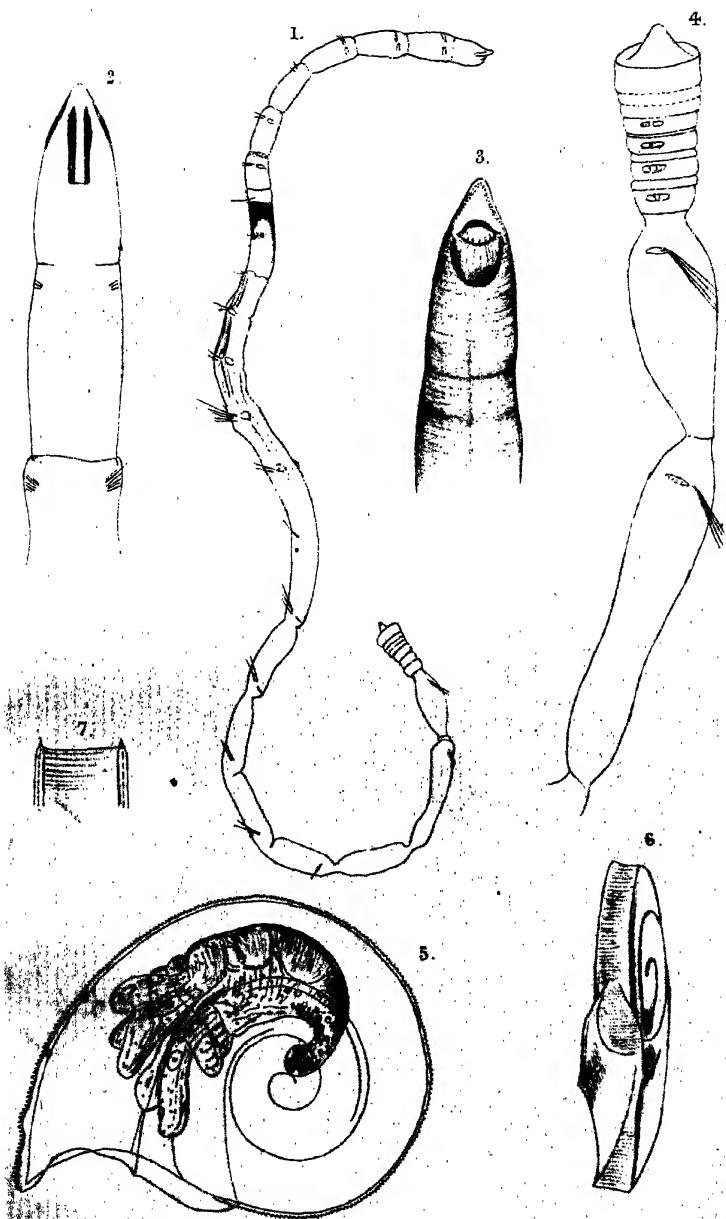
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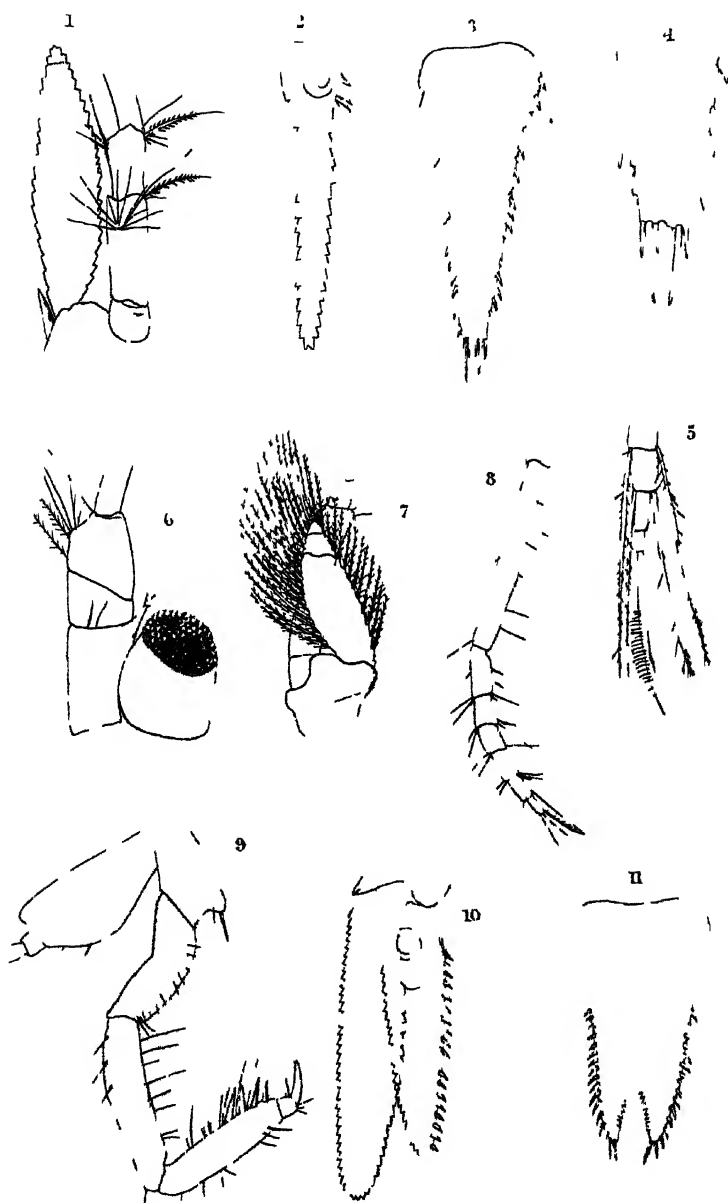
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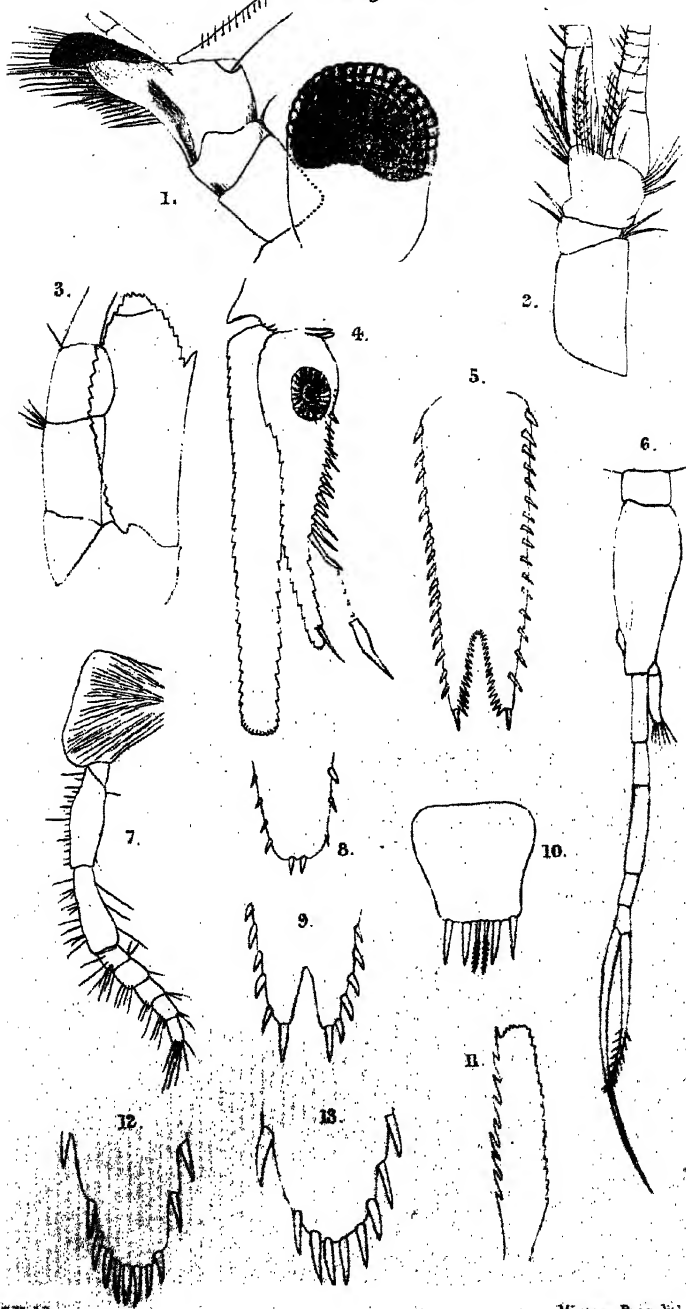


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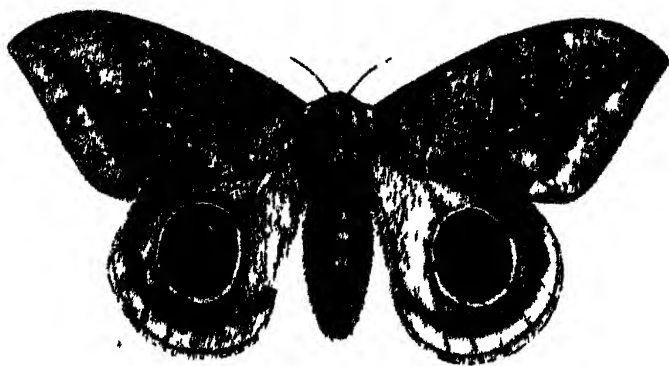


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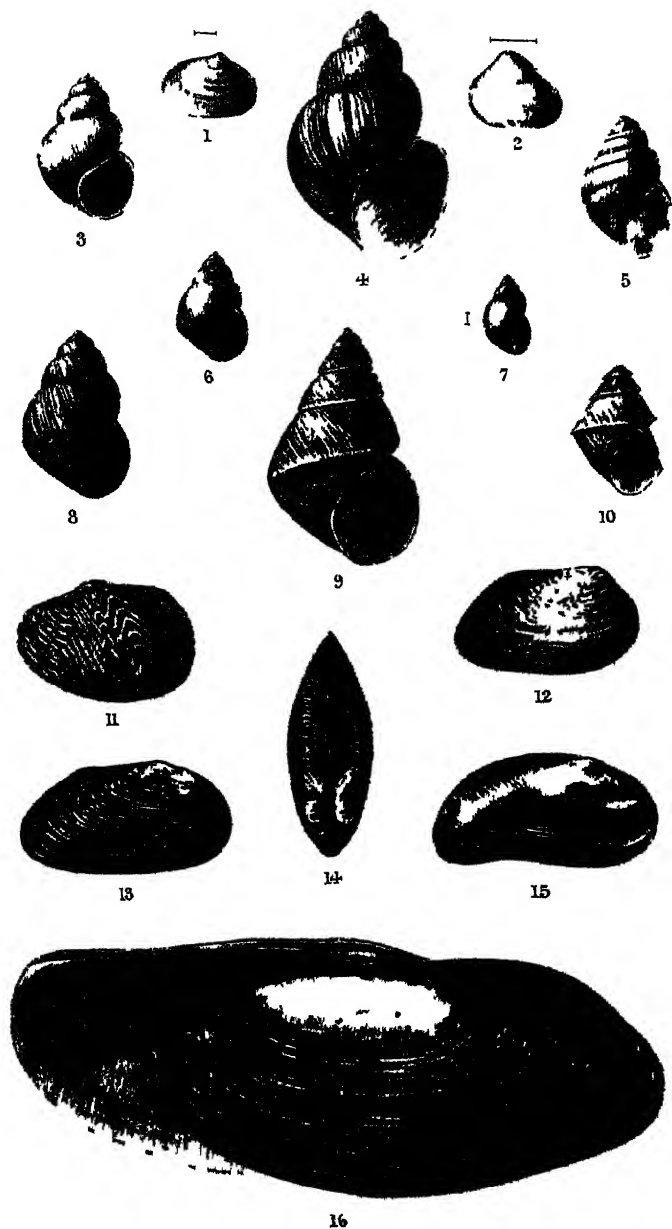
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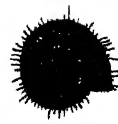
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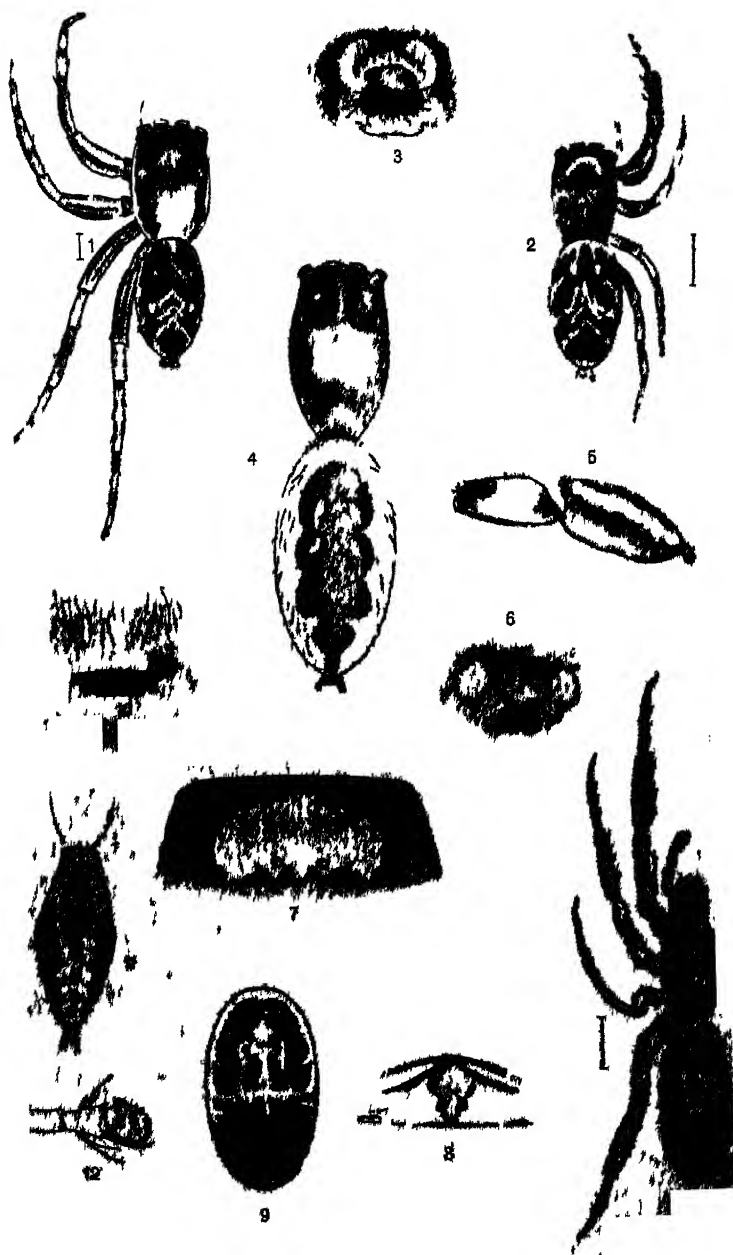
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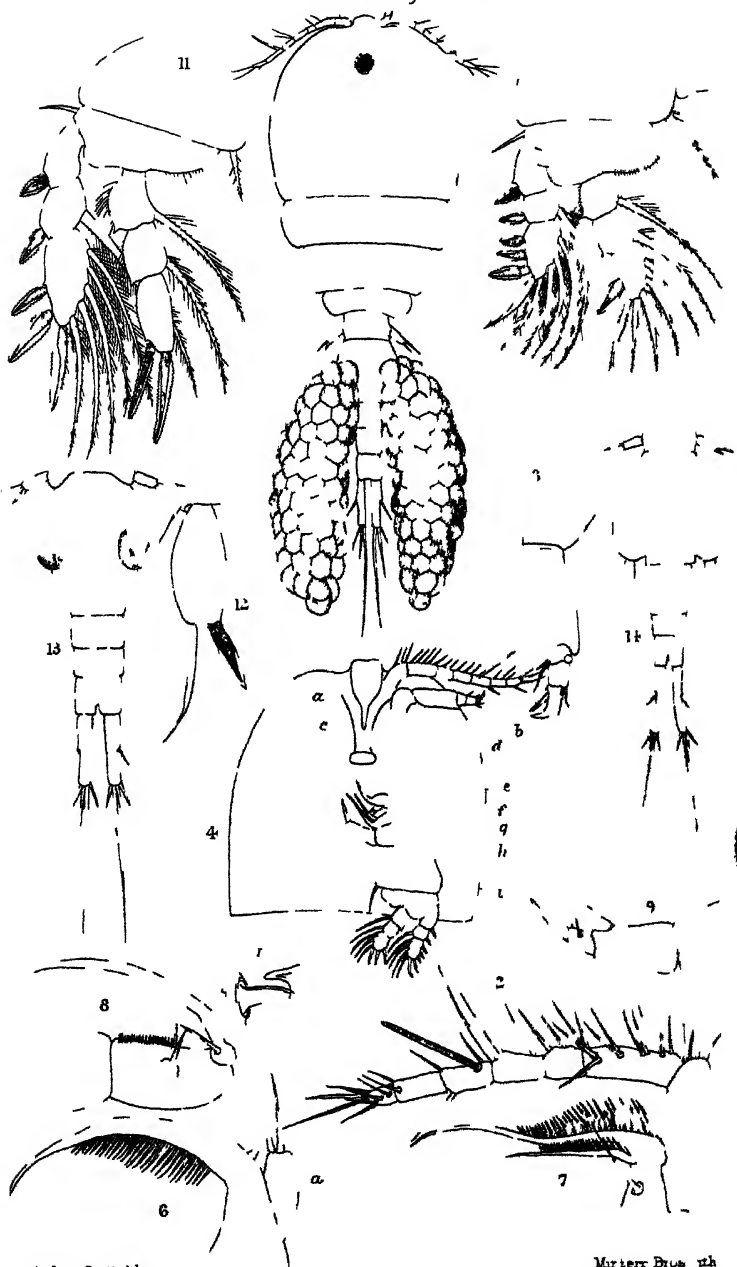


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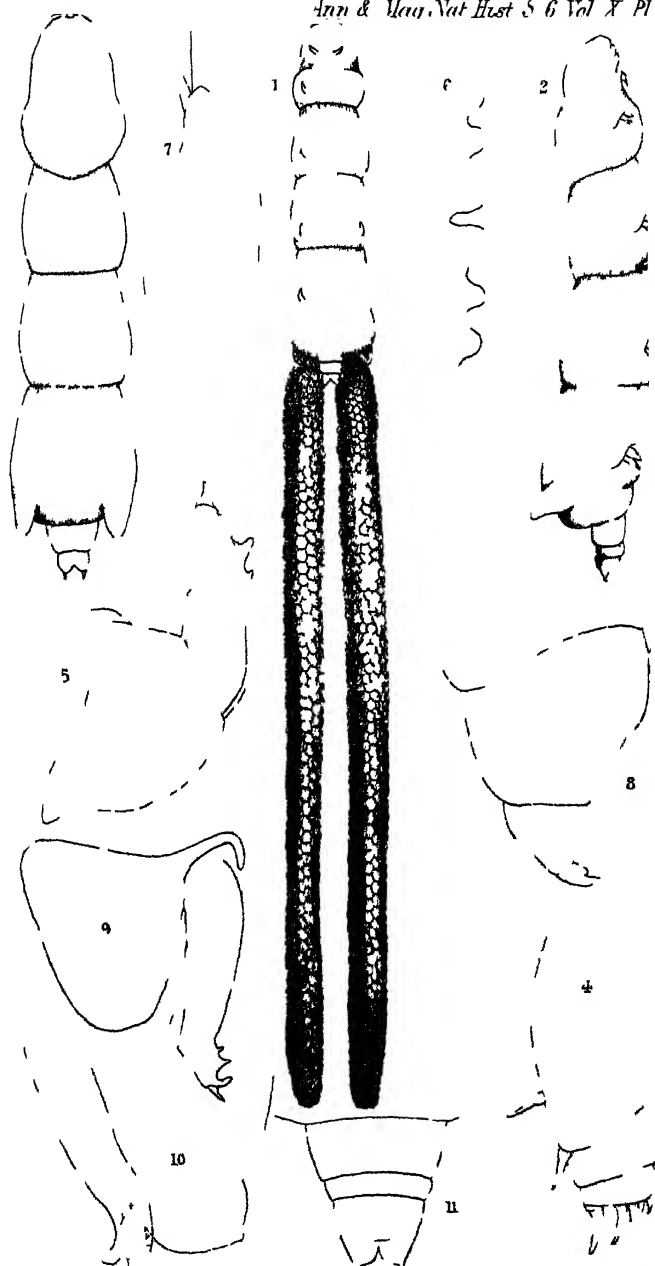




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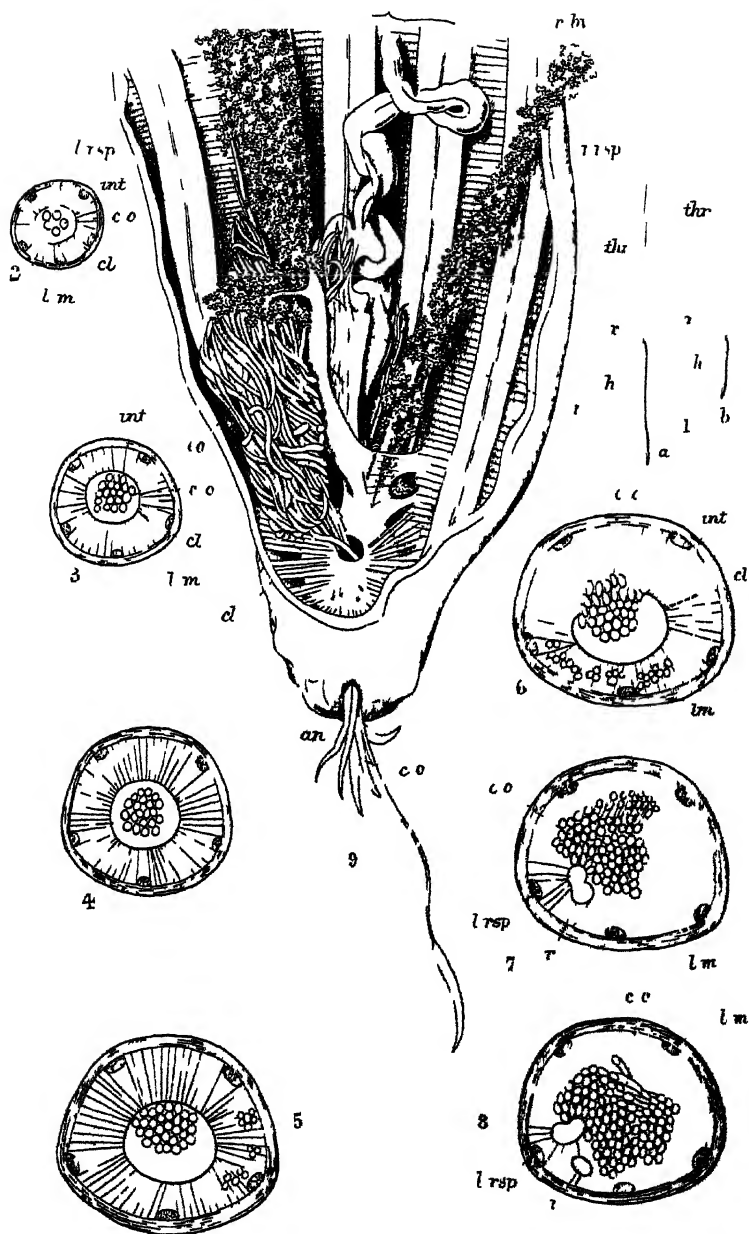
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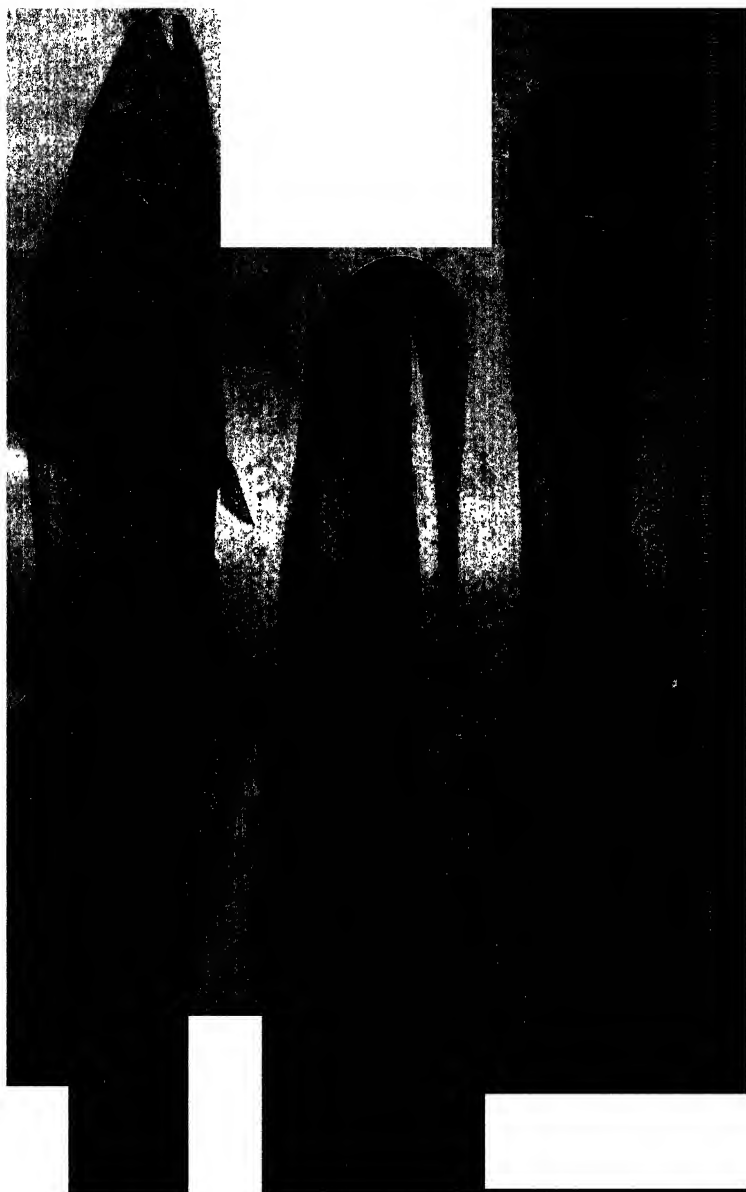


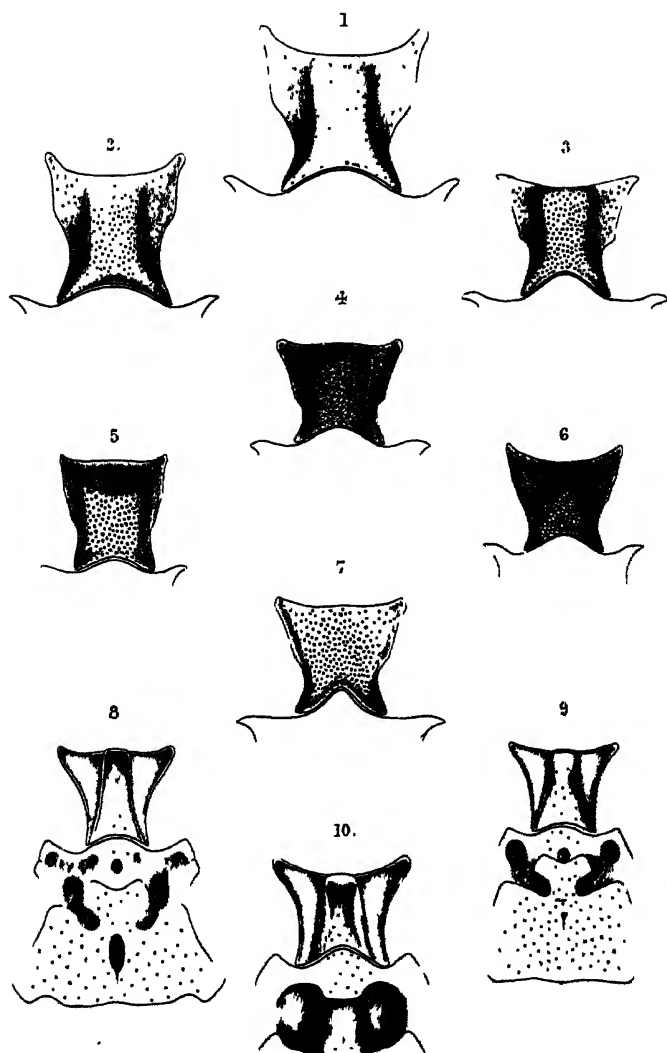
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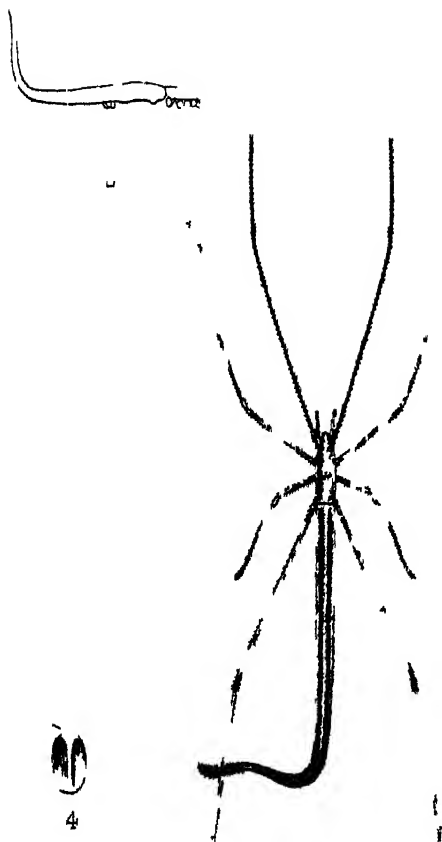
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